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Cover Photograph: *On Mindoro Island, in the Philippines, a Hanunóo shifting cultivator is required to leave a "detour marker" when a clearing is made across an established trail. Inscribed on the outer surface of the bamboo cylinder in this photograph is a message written in the Hanunóo syllabary telling the traveler where he should walk to avoid an area recently cut over — but still unburned — for purposes of shifting cultivation.*

Courtesy, Harold C. Conklin

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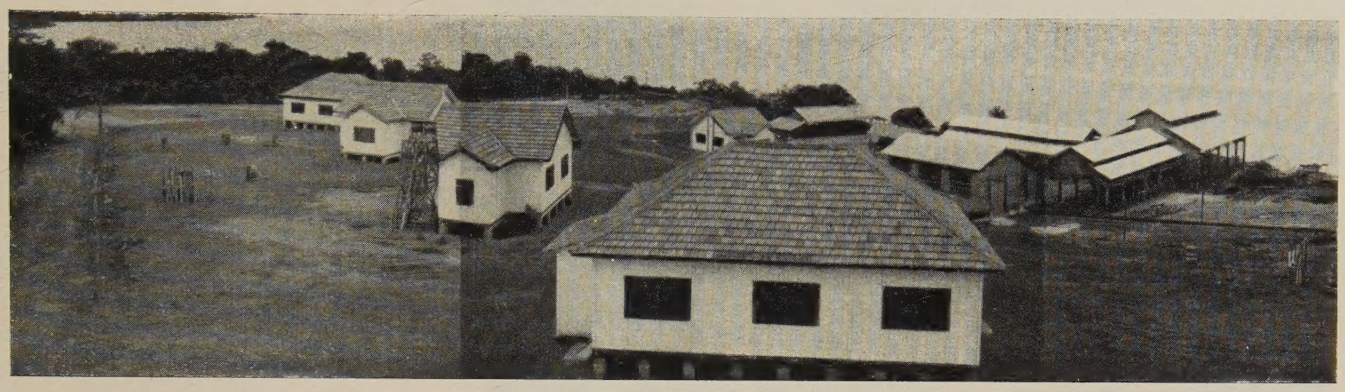
An International Review of Forestry and Forest Products



PRODUCTIVITY IN FOREST OPERATIONS

PRODUCTIVITY may be measured in terms of output per worker or per unit of resources, such as output per hectare. Higher production per unit of area over a given period of time generally means that production per worker is raised, although productivity per worker and per hectare do not necessarily march in step. Production per hectare may be increased by intensive methods without raising labor productivity, and mechanization or rationalization of work methods may raise labor productivity without necessarily raising total production or production per hectare.

However, the importance of research and extension in relation to raising productivity is obvious. The inherent difficulty of matching in agriculture and forestry the technological and organizational achievements of concentrated industry, serves to emphasize the tremendous importance of a good extension system to bring the results of research to operators and workers.

An attempt to do just this in regard to logging and primary sawmilling is represented by the demonstration center created in Brazil by an FAO technical assistance mission, and located at Santarem 500 kilometers up the Amazon river and about half way between Belem and Manaus. The Director-General of FAO formally opened this center, which is shown in the photograph above, in August last. The Brazilian Minister of Agriculture and many other officials attended the ceremony. Brought into being through the persistent efforts of the FAO technical assistance team, this center is designed to demonstrate the most efficient techniques for getting timber economically out of the forests of the Amazon and converted on the saw bench. It follows a somewhat similar center established at Llancacura, Chile, some time ago.

Another example of extension efforts is afforded by the recent meeting of the ECE/FAO Committee on Logging Techniques and Training of Forest Workers which was held in Moscow in September of this year.

Specialists from 20 countries, members of the United Nations Economic Commission for Europe's Timber Committee or of FAO's European Forestry Commission, together with representatives from a number of international organizations, joined in a 10-days' tour of areas of the Soviet Union to study the country's forest working techniques at first hand.

The Committee, at this its second session, approved a series of practical measures to promote the sharing of information on the techniques used by different countries in forest work and to facilitate the introduction of internationally agreed norms and standards. In this way, it seeks to assist timber producers to increase the yields from forest work. An international scheme for tractor testing on a comparable basis was drafted, and preparations will go ahead to draft similar protocols for other types of forest machinery, such as power saws, barking machines, winches and chippers. The members exchanged experience on comparing the economics of various degrees of mechanization, analyzing mechanized forest operations from a technological point of view, and on the correct maintenance and use of mechanized forest equipment.

A number of conclusions were endorsed in the reports prepared by the International Labour Organisation on Occupational Safety and Health in Forest Operations, intended to raise standards of safety and health in logging. ILO was asked to draw up an international code of good forest practices, embodying approved safety directives for forest undertakings and forest workers. The Organisation's fellowship scheme for forest workers was highly commended.

All this serves towards raising productivity per worker, and it is this productivity, as measured by the value placed on the products of his work in the market, that ultimately determines the level of income per worker.

FIGURE 1. *Loading chips pneumatically into a railway box car.*

FIGURE 2. *Loading chips onto a scow British Columbia.*

Economics of Barking and Chip Production

A Report Based on Sawmills in Eastern Canada

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Over one million cords of sawmill residue were converted into pulp chips in Canada during 1955. A large proportion of this material was produced on the west coast of British Columbia where the integration of sawmills and pulp-mills is well established, but this method of utilization is also developing rapidly in Eastern Canada. The Forest Products Laboratories of Canada have been very active in aiding the development of this valuable means of utilizing material which is often wasted, and have published numerous reports on the subject.[1] This present report [2] deals with the economics of barking, chip production, and utilization and discusses the relative importance of the various factors.

The report is composed of the following main sections: barking costs, chipping costs, transportation and handling costs, allocation of raw materials costs, and general expenses. In so far as the barking process itself is concerned, the report deals with rotor type pneumatic debarkers because there were more of this type of whole-log barkers in operation in Eastern Canada than any other type.

These costs emphasize the general practicability of producing chips at the sawmill. Each situation, of course, must be assessed on its own merits. Sawmill chips are not waste wood but are a manufactured product of the sawmill. The market value of these chips should be roughly comparable to that of forest wood chips and the selling price to the pulp-mills closely connected to the selling price of round wood in any particular area.

Members of the staff of the Ottawa Laboratory visited most of the barking and chipping installations in Eastern Canada and discussed the various factors with a large number of authorities. It is felt that the figures presented herein are accurate and generally representative of conditions in this area, as of the date of the report.

[1] This report was prepared initially for the consideration of the Co-ordinating Committee on the Utilization of Sawmill Waste for Pulpwood. The Co-ordinating Committee was formed in 1950 by the Forest Products Laboratories of Canada to promote the use of sawmill waste for pulpwood in Eastern Canada and has been active since that time. It is composed of representatives of the sawlog and pulp industries, federal and provincial governments, universities and research organizations. The chairman and secretariat are provided by the Forest Products Laboratories of Canada.

[2] A contribution from the Ottawa Laboratory, Forest Products Laboratories of Canada, a Division of the Forestry Branch, Department of Northern Affairs and National Resources.

Barking Costs

The cost of whole-log barking at the sawmill using a rotor-type barker, based on the information obtained, may be allocated generally as follows: labor costs including compensation and unemployment insurance, power costs, maintenance, bark disposal and depreciation.

Labor costs

In Eastern Canada, the barker is usually set up as a unit independent of the sawmill. Logs are taken from the log pond, put through the barker and returned to another pond and thence go to the sawmill. In this way, breakdown or delay at either the sawmill or barker does not interfere with the operation of the other. One case is reported, however, in which the barker forms an integral part of the sawmill. Two men, one operator and one assistant, operate the barker, the log haul-up crew being the same as that normally employed by the sawmill.

The number of men required to operate the barker unit naturally varies to some extent. In one case, seven men were used, three at the log pond feeding the jack ladder, two on the conveyers, one operator and one assistant.

Generally, six men should be sufficient to operate the barker and some installations may be able to operate with as few as four, two feeding the jack ladder, one operator and one assistant. Average wage rates vary in different areas and, of course, the machine operator receives a higher wage than the remainder of the crew. The average rate in Eastern Canada will usually be in the vicinity of 90 cents to $1.15 per man hour and assuming, for purposes of discussion, a six-man operating crew and a $1.05 per hour average wage and a nine-hour day, the total direct labor costs amount to $56.70 per day.

The machine will bark, on the average, between 54 and 60 thousand board feet per day or about 6 MBF [3] per hour. Burchill (1) reports a capacity of 57 MBF per nine hours in small spruce logs averaging 32 ½ board feet per piece, mill tally, and another firm reports 60 MBF per 10 hours in somewhat larger logs. However, on the basis of 57 MBF per nine hours, the direct labor costs amount to $\frac{\$56.70}{57{,}000} = 99.5$ cents per MBF.

Several indirect labor costs must be added to the above, including unemployment insurance and compen-

[3] MBF = thousand board feet

sation. Unemployment insurance costs the employer 60 cents per week for each employee earning $56.70 per week. On the basis of six men operating the barker, this amounts to $3.60 per week or about $0.01 per MBF based on 57 MBF per day and a six-day week.

Compensation rates vary from province to province and from year to year but assuming a rate of $4.50 per $100 of payroll, which should be adequate for most conditions, the six men would cost $2.55 per day or $0.045 per MBF.

These are the main labor costs and in this case total $0.995 + $0.01 + $0.045 = $1.05 per MBF of logs barked. Other average wage rates can, of course, be substituted by individual operators to make those figures compare more closely with their own conditions but, on the whole, these figures will give a good indication of what the labor costs can be expected to be.

Power costs

About 80 horsepower is required to operate the barker plus the usual conveyors, the average power draw being of the order of 45 kilowatts per hour. If power costs 0.5 cent per kilowatt-hour, the power costs amount to 3.5 cents per MBF. If the rate is 3 cents per kilowatt-hour, the cost per MBF is about 21 cents. For purposes of this report, power costs are taken as amounting to 15 cents per MBF.

Maintenance

In a well-run operation, maintenance costs appear to average between 20 cents and 30 cents per MBF. If the tools are replaced every four months at a cost of $95 per tool, the cost is 8 × $95 = $760 or roughly 13.5 cents per MBF. Oil, grease, repair materials, machine shop work and daily maintenance costs amount to about 10 cents per MBF. In this example, maintenance costs are taken as 25 cents per MBF.

Bark disposal

Bark disposal is an item which cannot be ignored and in some cases forms a considerable portion of the total cost of barking. One firm reports that bark disposal is carried out at their barker operation by one truck at $30 per day or 52.5 cents per MBF. This is apparently a higher cost than can be expected at many operations. Another disposes of bark by spreading and levelling with a bulldozer on a part-time basis. For the purposes of this report, bark disposal costs are assumed to amount to 52.5 cents per MBF, but at many mills this could well be expected to be less.

Depreciation

When calculating depreciation, a number of methods may be used. The diminishing balance method is employed for income tax purposes but generally the straight line method is used by sawmill firms for calculations of this nature. In this latter method, the total cost is written off in equal yearly amounts.

TABLE 1. — BARKER DEPRECIATION IN RELATION TO ANNUAL VOLUME BARKED

Volume barked, in million board feet	Depreciation, per thousand board feet $
5	2.37
6	1.98
7	1.70
8	1.48
9	1.32
10	1.19
15	0.79

The cost of a conventional 26-inch (66 centimeter) barker is approximately $30,000 and if the cost of a building, installation, etc., is added, the total cost ranges from $45,000 to $55,000. Taking a cost of $50,000 as being generally representative and depreciating over

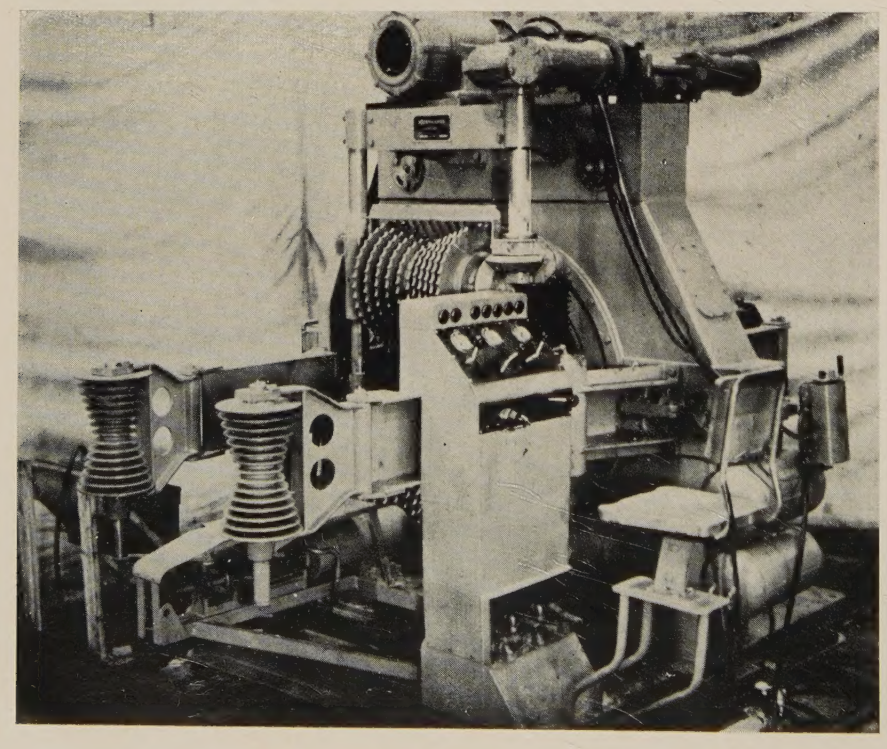

FIGURE 3. *The Andersson pneumatic barker.*

five years, the yearly charges amount to $11,870 (assuming the $50,000 is borrowed at 6 percent and a sinking fund established to retire the debt in five years). The depreciation per MBF varies according to the total volume barked per year.

For this example, a yearly volume of 7 million board feet is assumed, giving a depreciation cost of $1.70 per MBF.

Total barking costs

The total barking costs per thousand board feet, based on the provisions mentioned, are therefore, as follows:

TABLE 2. — TOTAL BARKING COSTS

Item	Cost, per thousand board feet $
Labor	1.05
Power	0.15
Maintenance	0.25
Bark disposal	0.525
Depreciation	1.70
TOTAL	3.675 or say 3.68

Moving costs

Although the barker is usually set up as a stationary installation, one firm has employed the barker as a portable unit, moving it about three times per year. They report that a move can be accomplished by the normal operating crew in a period of about one week, at a cost of approximately $300.

Volume of chips

The volume of chips per MBF of lumber sawn depends on the size of logs, type of sawmill and the utilization standards of the mill. When buzz barkers are used on the slabs and edgings, the recovery generally ranges between 0.4 and 0.7 cords of slabs and edgings per MBF, sawn. Usually, however, not all of the slabs and edgings are barked on the buzz barkers, the smaller ones being discarded. With whole-log barkers, slabs and edgings recovery amounts to at least 0.7 cords per MBF under normal conditions in Eastern Canada and may exceed 0.85 cords per MBF. A figure of 0.8 cords per MBF is used in this case and in most instances will probably be representative.

The cord is a somewhat indefinite unit of measurement because of the variation in solid wood volume and most companies are using the bone-dry ton as a unit of measurement. Studies by this laboratory (2) have shown that a cord of barked spruce and balsam fir slabs and edgings will average about 77 cubic feet solid wood per stacked cord, under Eastern Canadian conditions, and for purposes of standardization in this report the following are considered as equivalents:

1 stacked cord (barked) of slabs and edgings	= 77 cubic feet of solid wood
	= 1,875 lb. bone dry
Recovery per MBF [4]	= 0.8 cords = 62 cubic feet of solid wood
	= 1,500 lb. bone dry
	= 0.75 bone dry ton (bdt)

Total barking costs of slabs

Since total barking costs per cord (and per bdt) and edgings have been calculated, in this case, to amount to $3.68 per MBF, the cost per cord, based on 0.8 cords per MBF is $\$3.68 \times \frac{1.00}{0.8} = \$4.60$.

The cost of barking per bdt is $\$3.68 \times \frac{2000}{1500} = \$4.91$.

CHIPPING COSTS

Chipping costs vary to some extent but are much smaller than barking costs. A satisfactory chipper for slabs and edgings, with power, conveyors, and screens, installed, costs about $20,000. Two men are usually stationed on the conveyor to the chipper to regulate the feed and to ensure that all bark has been removed from the wood being chipped. Cost of chipping is roughly as follows.

Labor

Two men at $1.05 per hour, nine hours per day, cost $18.90. If 43 bdt of slabs and edgings are produced (0.75 of 57 MBF) the direct labor cost amounts to $0.44 per bdt. Adding compensation costs at 2 cents per bdt and unemployment insurance at 0.5 cent per bdt, the total labor costs amount to 46.5 cents per bdt. (A comparable figure is 44 cents per cord.)

Power

About 80 horsepower is needed to operate the chipper and conveyors (or fans) to the railway car or hopper. If the same figures on power consumption are used as was the case with the power costs of barking, the power costs amount to 4.5 cents per kilowatt-hour. Figures for this example are taken at 20 cents per bdt. (A comparable figure is 19 cents per cord.)

[4] Recovery per thousand board feet may be calculated as follows: studies (3) by this laboratory have shown that it requires between 176 and 200 cubic feet of solid wood in log form to produce 1 thousand board feet of sawn lumber. Assuming an average of, say, 185 cubic feet per MBF and a yield of slabs, edgings, and trim of 34 percent, the yield is 63 solid cubic feet per MBF of chippable material. Some of the short trim ends will not be chippable so the actual yield is probably closer to 62 solid cubic feet per MBF.

Maintenance

The chief maintenance costs are the sharpening and periodic replacement of the chipper knives. Total maintenance costs amount to approximately 5 cents per bdt.

Depreciation

Yearly depreciation of a $20,000 chipping installation amounts to $4,750 based on a five-year period (assuming the $20,000 is borrowed at 6 percent and a sinking fund is set up to retire the debt in five years). The cost per bdt and per cord is given below for various volumes.

TABLE 3. — DEPRECIATION COSTS ON CHIPPER INSTALLATION

Volume barked per year, in million board feet	Bone-dry ton per year (based on 3/4 bdt per thousand board feet)	Cords per year (based on 0.8 cords per thousand board feet)	Depreciation	
			per bone-dry ton $	per cord $
5	3 750	4 000	1.27	1.19
6	4 500	4 800	1.06	0.99
7	5 250	5 600	0.90	0.85
8	6 000	6 400	0.79	0.74
9	6 750	7 200	0.70	0.66
10	7 500	8 000	0.63	0.59
15	11 250	12 000	0.42	0.40

In this example, with 7 million board feet being barked, the depreciation costs on the chipper installation amount to $0.90 per bdt or $0.85 per cord.

Total chipping costs

The total chipping costs based on these provisions are, therefore, as follows:

TABLE 4. — TOTAL CHIPPING COSTS

Item	Per bone-dry ton $	Per cord $
Labor	0.465	0.44
Power	0.20	0.19
Maintenance	0.05	0.05
Depreciation	0.90	0.85
TOTAL	1.615	1.53

The total cost of whole-log barking and the chipping of the resulting slabs and edgings is, therefore, $4.91 + $1.615 = $6.525 per bdt or $4.60 + $1.53 = $6.13 per cord.

TRANSPORTATION AND HANDLING COSTS

It is very difficult to generalize on handling and transportation costs because of the variety of methods in which these operations are carried out. For short hauls, trucks are usually employed for the transport of chips. Chips are conveyed from the chipper to a hopper and thence loaded into trucks. On short hauls of up to 10 miles (16 kilometers), a suitable truck costing about $30.00 per day (with driver) could be expected to handle between 10 to 15 cords (or bdt) at a cost of between $2.00 and $3.00 per cord. This would bring the total cost, delivered at the pulp-mill, to between $8.13 and $9.50 per bdt or per cord.

For longer hauls, it is general practice in Eastern Canada to use railway box cars. Costs per cord for conveying, either by bar type conveyor or pneumatic, to the box car, moving cars at the mill, etc., are roughly as follows:

Freight rates vary, of course, in different parts of the country and with the length of haul. Assuming a rate of 10 cents per hundred for a hundred mile haul,

TABLE 5. — CONVEYING COSTS PER CORD

	$
Power (bar conveyor or air equipment plus car moving device)	0.04
Maintenance	0.02
Depreciation	0.07
Labor including placing in car doors, etc.	0.27
Car door expenses	0.17
Demurrage	0.01
TOTAL	0.58

the freight costs amount roughly to $3.00 per cord (green cord assumed to weigh 1.5 tons).[5]

Total cost of loading and freight in this case is $3.00 + 0.58 = $3.58 per cord, and the cost delivered to the pulp-mill, therefore, varies between $9.70 and $10.10 per cord (or bdt).

It should be emphasized that this section is composed of examples only and is shown here merely to give some indication of the order of the costs of this phase of chip production.

ALLOCATION OF RAW MATERIAL COSTS

The fact is sometimes overlooked that when a sawmill commences chip production, a portion of the cost of the raw material (logs) should logically be borne by the chips. (This, of course, is the general practice in Scandinavia where this type of operation has been in existence for some time). In a single product operation,

[5] A green cord of spruce can be expected to weigh about 1.5 tons. Green moisture content of spruce averages from 55 to 75 percent, which at a S. G. of 0.37, 77 solid cubic feet per cord and an average of 70 percent = 1.5 tons.

such as a sawmill producing lumber as its main product, the entire cost of raw materials is borne by the one main product, and usually no portion of the raw materials cost is assigned to any by-product produced. However, in the case of a joint product operation, such as a sawmill producing lumber as the main product and chips as the joint product, it is usual to assign a portion of the cost of the raw materials to the joint product. This may be done on an equal basis but often the joint product bears only a percentage of the cost borne by the main product.

For example, 185 cubic feet of logs (solid wood) delivered to the sawmill will produce 1 MBF of lumber (92 cubic feet),[6] 0.8 cord of chippable material and about 31 cubic feet of sawdust. If the logs are spruce and cost $42 per MBF at the mill and if the sawdust is discarded or burned and no materials costs assigned to it, the allocation of raw materials cost to lumber and to chips might be as follows:

> Cost of logs to produce 1 MBF of lumber and 0.8 cord of chips = $42.
>
> Therefore, cost of 92 cubic feet of lumber and 62 cubic feet of solid wood = $42.
>
> Suppose the raw material cost for the chips is set at one third that of the lumber per cubic feet of solid wood. (This is a quite usual proportion in operations of this nature, but, of course, can be greater or less depending on the policy of the management.)
>
> The cost of raw materials can then be calculated to amount to $34.30 per MBF for the lumber and $7.70 per 0.8 cord of chips. Cost of raw materials is, therefore, 1.25 of $7.70 = $9.60 per cord of chippable material.

On this basis, the value of the chips, delivered to the pulp-mill would be of the order of $20.00 per cord or per bdt.

It should be mentioned again that this is an example only and has been included to emphasize the fact that once a sawmill enters into the chip production field, it becomes a joint product operation and the chips should bear some of the cost of the raw materials. The proportion of this cost is for the decision of management, but, in any event, the selling price of sawmill chips should be closely connected to that of forest wood chips in any particular area.[7]

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[6] One thousand board feet of lumber is equivalent, nominally, to 83.3 cubic feet but usually the lumber is full sawn and studies by the Ottawa Laboratory have shown that, in Eastern Canada, the actual volume is about 92 cubic feet.

[7] Acknowledgement is made to the following for advice and assistance in obtaining the information on which this report is based:

J. G. Burchill, Geo. Burchill and Sons Ltd., South Nelson, New Brunswick; P. Morley, Canadian International Paper Co., Gatineau, Quebec; R. L. Seaborne, Mersey Paper Co. Ltd., Liverpool, Nova Scotia; A. Murray, Price Bros. and Co. Ltd., Rimouski, Quebec; A. W. Goodfellow, Fraser Companies Ltd., Plaster Rock, New Brunswick; C. R. Silversides, Abitibi Power and Paper Co. Ltd., Toronto, Ontario; A. Jessop, Forano Ltd., Plessisville, Quebec.

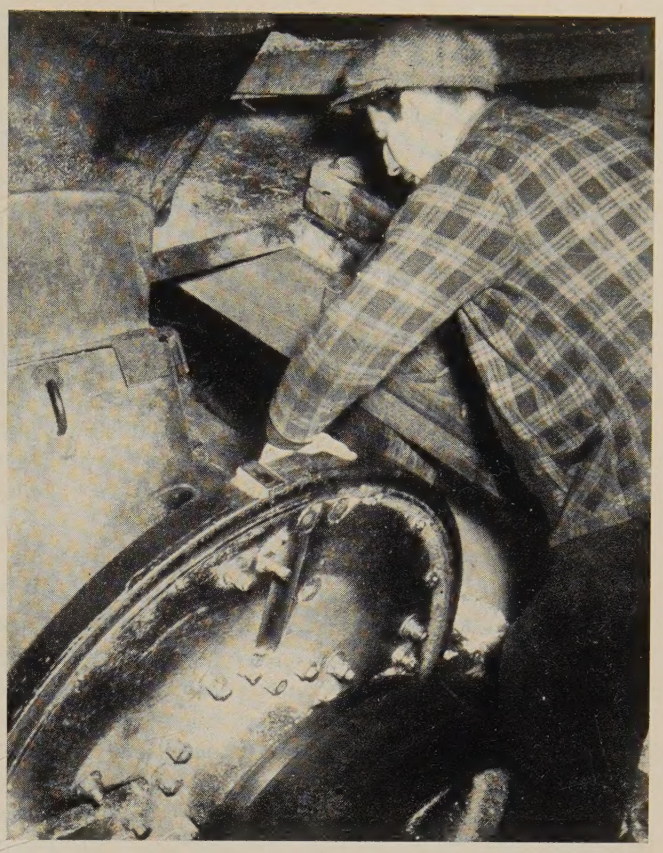

FIGURE 4. *A chipper used in a sawmill in Eastern Canada to convert slabs and edgings into chips.*

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(1) BURCHILL, J. G., The Andersson barker, *Timber of Canada*. December, 1955.

(2) BELL, G. E. and E. BROOKS, Cord-cubic volume relationship of slabwood and edgings. *Timber of Canada*. November, 1954.

(3) BELL, G. E., *Factors Influencing the Manufacture of Sawlogs into Lumber in Eastern Canada*. Bulletin 99, Forest Products Laboratories of Canada. Ottawa, 1951.

CONVERSION FACTORS

1 inch	= 2.540 centimeters
1 foot	= 0.3048 meter (1,000 feet: 304.8 meters)
1 cubic foot	= 0.02832 cubic meter
1 mile	= 1.609 kilometers
1 pound	= 0.4536 kilogram
Roundwood (general)	1 cubic foot = 0.0283 cubic meter
Sawlogs	1,000 board feet = 4.53 cubic meters
Sawnwood	1,000 board feet = 2.36 cubic meters

1 stacked cord (barked) of slabs and edgings
= 77 cubic feet of solid wood
= 2.1806 cubic meters
= 1,875 pounds
= 890.42 kilograms

The Influence of Forest Vegetation on Water and Soil

H. G. Wilm
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As a feature of its current program of work, the Forestry Division of FAO is preparing for publication a study on the influence of the forest on water, soil and climate, and their bearing on land-use policy. This article, is an extract from the concluding chapter by Dr. Wilm. Other contributors to the study are: Professor Joseph Kittredge, Dr. R. J. van der Linde and Dr. Marvin D. Hoover: a general introduction is given by Professor Aldo Pavari.

If any broad generality can be stated about the problem of forest influences in the arid and tropical humid zones, perhaps it is this: that these influences tend to be more striking and pronounced than in more temperate zones; and that, therefore, the need for wise and careful management of forest vegetation is more acute, so as to achieve optimum regulation of water and stability of soil. If this is true, it means that the forest land manager has a particular need to understand the principles underlying forest influences, so that he can know how to protect or manipulate the vegetation on his land to attain the desired objectives. As background for the present development of forest land-management policies and procedures, these principles will be reviewed and summarized to indicate the relation of forest vegetation to climate and especially precipitation; to surface runoff and land stability; and to the regimen of streams. Particular reference will be made to the effects of forest manipulation, as a guide to the management of watershed land.

Forest influences

One of the earliest and most widespread conjectures on the relation of forests to water has been their influence upon climate. As suggested elsewhere (Kittredge, 1948), this influence is hard to prove or disprove in terms of general regional climate. The areas compared are necessarily large, and inherent variations tend to obscure any regional effect of the presence or absence of forest vegetation. At least in certain cases, however, there seems to be a strong rational basis for arguing a regional effect. Where forest vegetation occurs in areas exposed to warm maritime air masses, it seems quite likely that the presence of the forest exerts a measurable effect upon total precipitation and perhaps upon regional climate. Illustrations are the redwood forests along the Pacific coast of the United States, and certain forest areas in West Africa.

Entirely aside from conjectural regional effects, forest vegetation is known to exert substantial effects upon local climate within and adjacent to its own area. Universally, as can be testified by anyone who has taken shelter under trees or in the lee of shelter belts, the presence of forest vegetation tends to ameliorate local climate. Maximum temperatures are lowered and minima raised; relative humidity is a little higher; and wind velocities may be reduced a little or a great deal. These are generally beneficial influences, especially in arid regions. But of greater interest to the watershed land manager is the influence of forests upon local precipitation, runoff, soil movement, and water losses.

As precipitation falls on forest cover, the first influence is interception. Depending on the character of precipitation and the density of the vegetation, a variable amount of water is held by the forest canopy and evaporated into the atmosphere without reaching the ground. Experimental data obtained for a variety of forest types and climates indicate that the amount of precipitation intercepted by a forest canopy is a purely mechanical function of the storage space available on vegetation surfaces when the rain begins. A heavy forest of trees with long, dense crowns can therefore be expected to intercept maximum amounts of water from any storm; minimum interception would be expected from a thin cover of sparse vegetation. Aside from the effects of the kind and density of vegetation, however, interception tends to become less as a storm progresses and the forest canopy becomes wetter. Toward the end of a large long storm, only enough additional water is retained on the crowns to offset any evaporation from the leaf surfaces that occurs during the storm. Thus the greatest possible losses of water could be expected in climates that are characterized by a large number of light, small storms, separated by periods of clear weather. But in any event, interception means a loss of precipitation through evaporation.

Aside from this loss, forest vegetation also consumes water by evapo-transpiration. After precipitation has passed through the forest canopy, some or all of it moves into the soil. Some fills up storage space available in the "pores" of the soil: filling the capillary

spaces and then, if a sufficient volume of water is applied, the larger, non-capillary spaces. As the storm proceeds to its end, water in non-capillary storage passes on by gravity; either into deeper storage, to ground-water tables, or through subsurface flow into streams. The remaining water is held against gravity in the soil and some or all of it is drawn back out into the atmosphere by direct evaporation or transpiration through the roots and canopies of vegetation. The volumes of water consumed in this fashion vary with temperature, humidity, and wind movement; with the volume of soil-water in storage, with the extent and depth of rooting systems, and with the amount of time which elapses between storms.

The relative amounts of water consumed by direct evaporation and by transpiration through vegetation can be reasoned out, although they are not easily separable in actual measurement. Direct evaporation occurs from water standing on the soil surface or in the interstices of the soil. Rates of evaporation are greatest at or near the surface and decrease rapidly with depth, reaching negligible rates at depths of perhaps one-half-meter or so in most soils. It may occur at greater depths, of course, if the soil mantle is deeply cracked and fissured. Then, in effect, the area of land surface exposed to air is increased and projected into the soil mantle.

As to transpiration, the total volume of water removed depends upon several inter related factors: not only the volume of water available in soil storage, but also the depth and completeness of root systems, and the hydrologic depth of the soil. The greatest amounts of water are consumed by transpiration through deep and complete systems of roots in deep soil, penetrated to its full depth by stored water. On the other hand, transpiration may be decidedly limited if the root systems are restricted by low density of vegetation, or by a shallow hydrologic depth of the soil: where the penetration of water into soil is restricted, either by the presence of a dense layer such as rock or clay a relatively short distance below the land surface, or by deficient precipitation which never penetrates beyond a relatively shallow depth.

Transpiration naturally decreases with reductions in vegetation density, and evaporation tends to increase. Thus, in shallow soils the sum of evaporation and transpiration would tend to remain constant even with variations in the density of vegetation — as observed by Wilm and Dunford in Colorado (U.S.A., 1948). Where the soil is deep, vegetation dense, and precipitation abundant, as in the Southern Appalachian Mountains of United States, on the other hand, the removal of vegetation reduces evapo-transpiration and increases water yield to a pronounced degree (Hoover, 1944).

Perhaps these thoughts deserve further amplification. According to Thornthwaite's (1955) concept of "potential evapo-transpiration", a calculable amount of water will be moved into the atmosphere from a land surface for any given set of conditions — and with a continuously ample supply of water in the soil. With an abundant water supply, plants tend to transpire in proportion to their receipt of solar radiation. But as soil-water supply decreases, plant stomata close and transpiration decreases even though solar radiation remains high.

Thus the actual losses of water from a soil mass are commonly lower than the "potential" quantities because of deficiencies in soil water supply. In arid climates, the total precipitation may be only a small fraction of the potential consumption; and this potential amount can be attained only in areas of continuously high ground-water (Wilm, 1952). Hence it is only in such areas — along streams or at oases — where abundant vegetation can develop. In some arid localities, as in the southwestern United States, such vegetation causes serious losses of water yields.

Where ground water is not available, on the other hand, water consumption in arid areas is only the amount of water that penetrates the soil from precipitation. After surface runoff is subtracted, this consumption is only a few inches or centimeters per year. And, because this water penetrates only a short distance into the soil before being consumed, it is all lost by either evaporation or transpiration, whether vegetation is present or absent. Under such conditions, vegetation has little or no influence on water consumption; but it still serves an important function in soil stabilization.

Extension of these ideas suggests that actual evapo-transpiration may be expected to increase with increases in available water supply, up to a maximum equalling potential evapo-transpiration. This seems to be generally true; but two examples will illustrate that the underlying principle should not be oversimplified.

First, it is often inferred that actual evapo-transpiration is independent of variations in vegetation, as long as the ground surface is well covered. This might be true if the available supply of water to vegetation did not change such variations in vegetation. Such a condition would be found in areas of constantly high water-table or of shallow soils and root systems. But consider an area of deep, well-drained soils and abundant, but well-distributed precipitation with sunny periods between rains. If no vegetation existed or if it had only shallow root systems — say, less than 0.5 meter deep — the total water available for evapo-transpiration must certainly be far less than if the vegetation were a mature forest with deep, fully-developed root systems occupying a column of soil perhaps two meters deep. The effect of removing such a forest and replacing it with a dense young sprout-hardwood forest is graphically shown by experiments in the southeastern United States (Hoover, 1944, Kovner, 1945). There, the removal of a mature hardwood forest decreased annual evapo-transpiration from about 39 inches (99 centimeters) to about 20 inches (51 centimeters). As the sprout forest grew up, the annual water loss slowly increased again. Even 12 years after the clear-cutting, however, the remaining loss was still several inches smaller than before treatment.

Second, it is often considered that evapo-transpiration opportunity increases directly with annual precipitation. This may be generally true when total annual precipitation does not greatly exceed potential evapo-transpiration. But in humid areas with excessive precipitation, it seems logical that evapo-transpiration opportunity may actually decrease with further increases in precipitation. This seems to be illustrated by precipitation-runoff relations in the Luquillo Mountains of Puerto Rico, where precipitation is around 200 inches (500 centimeters), and approximate runoff data indicate total evapo-transpiration losses around 20 inches (50 centimeters) or less. Incidentally, this particular area is characterized by a dwarf "rain forest", which might also indicate suppressed transpiration rates.

Aside from its influence on the volume of evapo-transpiration, forest vegetation exerts other extremely important influences upon the disposition of water. After precipitation has passed through the forest canopy, not all of it may enter the soil, passing into soil storage or ground water and then moving in a tranquil manner into streams. Depending upon the rate of precipitation and the density of upper soil, smaller or larger quantities of water may run off over the land surface. Precipitation rates cannot be controlled by land-management activities; but the density of the upper soil layers may be affected tremendously by the growth, manipulation, or deterioration of vegetation. As an undisturbed forest vegetation develops, it tends to build a more and more favorable environment for the formation of permeable soil. Organic litter is first deposited upon the land surface. As it begins to decompose, organic decomposition products move into the upper soil, providing favorable conditions for bacteria and other plant and animal life to go to work in building soil structure. Also, a network of "feeder" roots penetrates throughout the topmost soil layers, providing mechanical stability as well as creating myriads of underground channels as they die and rot.

Thus, over a period of time the development of forest cover builds optimum conditions for the penetration and storage of water. On the other hand, the removal of vegetation — even without mechanical disturbances — tends to cause degenerative changes to a greater or less degree. Removal of the sheltering canopy exposes litter and humus to increased oxidation, to the impact of rain, and to removal by wind. Progressive deterioration of microfauna and flora, the loss of feeder roots without replacement, and the battering of rain all tend to compact the surface layers until, at some critical stage of deterioration, surface runoff begins to occur. If, then, the recovery of vegetation is not accomplished, a progressive cycle of further deterioration develops. Surface runoff stirs up sediment, which passes into the upper soil interstices; this means lowered porosity, which means further increased surface runoff, and so on. The cycle ends in a relatively stable condition of low infiltration and storage capacities of the watershed, and excessive rates of surface runoff. High floods occur in the streams during rainy periods, and dry channels between the storms.

Such watershed degeneration is aggravated by mechanical soil compaction caused by the cutting of skid trails and the construction of roads; by the movement of logs; by the pressure of heavy logging machinery; and by the trampling of animals while working or grazing. On pastured and range lands especially, trampling of animals can be an important cause of watershed deterioration. So also can trampling by human beings, in areas of high concentration.

From this discussion it can be seen that the whole object of watershed management or protection is to avoid causing deterioration of forest cover to a point beyond the critical stage of degeneration. In some areas, with relatively porous soils and low rates of precipitation, this may permit quite heavy use of the vegetation without serious damage. In other areas, with high rate of precipitation and easily damaged soils, it may require complete protection from any kind of use.

In summary, then, several statements can be made regarding forest influences on water supply, soil stability, and stream regimen. As a generality, vegetation consumes water in varying amounts, depending upon the climate and character of vegetation. Ordinarily such water consumption is an important factor in watershed management; although in extremely arid or wet climates or where the soil is hydrologically shallow, the presence or absence of vegetation may make little difference in the total yield of water from precipitation. Its presence may, however, exert a tremendous effect in stabilizing soil and regulating streams.

If, therefore, the primary object of land management is flood regulation and soil stabilization, the aim should be to maintain the densest possible cover of vegetation. If, on the other hand, the object is to obtain maximum water yields compatible with soil stability and flood regulation, the land manager would want to maintain minimum densities of vegetation above the critical level of deterioration.

It will be noted that these concepts introduce policies for management and protection which differ from policies developed for timber production alone, and may be in conflict with them. The characteristic idea in forestry policies is the production of maximum volumes of timber per unit area. In contrast, the watershed land manager wants to maintain densities of forest cover which will provide the desired results in water-yield production and the stabilization of streamflow and soil. In some cases, this means complete protection of the vegetation, which yields no wood products at all. In other cases, where water yields are important, it means the maintenance of forest stands substantially lower in density than desired by silviculturists for maximum production of wood, Necessarily, in all cases these differing objectives must be harmonized so as to provide the greatest long-time returns to the greatest number of people concerned.

Application of principles to problem regions

Arid zones. As regards forest influences, the arid zones of the world may be considered to have two outstanding characteristics. First is an obvious shortage of water which, as civilizations develop, leads to intense demands. Second is a characteristically slow and sparse development of vegetation, correspondingly serious damage from exploitation, and slow recovery. These factors call for the most careful designing of forest land management to achieve optimum water production and watershed stability. Typically in the drier zones, any substantial encroachment upon the forest means a real setback in watershed conditions: one which takes a long time to overcome, and often goes beyond the critical stage into a severe cycle of deterioration which may end in permanent or semi-permanent desert. In West Africa, for example, the cutting and grazing of the forest in Northern Nigeria and the Sudan country has resulted progressively in the degradation of the deciduous forest, the development of "savannah" types, and the southward advance of the Sahara Desert (Stebbing, 1939). In some cases, however — probably where the soil is more pervious — the degradation of the deciduous forest may not result in deteriorated watershed conditions:

> "A degraded type of deciduous forest in which the fire-resisting species naturally predominate, becomes, in the course of decades or centuries of this treatment, of poorer height growth with contorted stems and an open cover. All this was represented today, the general average of height growth being about 25 to 30 feet (7.5 to 9 meters): though we got into patches, usually with dense elephant grass, of taller trees, and a dense canopy, even intact in a few places.
>
> The general character of the forest was what interested me. It is not yet past praying for. The water in this region, as I have noted, is still plentiful in the streams, and it is obvious that reservation here would retain and preserve the existing conditions, which are good. It is equally obvious that, if the people are allowed to continue firing the forest in the present fashion, the existing forest must gradually deteriorate to such a point that water supplies will be affected and that the present apparent prosperity of this region will be reduced." (Stebbing, 1939, page 41).

Stebbing suggests the establishment of belts of timber in an east-west direction to arrest the southward progress of the Sahara Desert: one across the Haute Volta and across to Lake Chad, and the other through the Gold Coast and Nigeria in the approximate latitude of Kintampo. He also seems to favor, in general, the preservation of timbered areas from public use as a means to preserving watershed conditions. Wherever shifting cultivation is practiced, he suggests the taungya method of planting trees immediately in the cleared areas, while they are being used for cultivation, as a means of land restoration. The taungya method should be combined with the regulated rotation of shifting cultivation, so as to give maximum opportunity for land recovery.

In the semiarid areas of the United States such as the Front Range of the Rocky Mountains and areas in Arizona and New Mexico, large tracts of land have been seriously deteriorated by generations of cutting, repeated fires, and overgrazing. The result in some cases has been depletion or removal of the forest cover; in others, invasion of grazing land by pinyon pine and juniper. Here, one solution has been the establishment of national forests in which timber cutting, grazing, and fire are under the regulation of the Federal Government. Occasionally, however, a consequence has been further overburdening of lands outside the national forests.

From these examples and others which might be cited it seems evident that, in the arid zones, the management of watershed lands calls for special care. In some cases it may be possible to remove timber to a considerable degree, if it is replaced by good stands of grasses and other forage plants and if grazing can be carefully regulated. Otherwise, too often the consequence is a prolonged cycle of serious deterioration.

Tropical humid zone. In these great areas of the world the climate and vegetation present a completely different set of problems. Typically, the precipitation is excessive — even to the point that evapo-transpiration may be suppressed below the theoretical maximum. Vegetation develops rapidly except in the wettest areas, and forms almost impenetrable cover which more than adequately protects the soil against erosion. After the forest is removed by clearing or burning, its return is so rapid that the soil is again completely covered in a surprisingly short space of time. At the same time, surface erosion from cleared land is severe; and shifting cultivation has been many times cited as the source of sediment, floods, and deteriorated soil. It is also associated with the existence of impoverished populations.

All of these statements are doubtless true at least to some degree; it is suspected that some of them have been overdone. Certainly, as a primitive form of agriculture, shifting cultivation is accompanied by corresponding waste of human effort and impoverishment of land. And erosion does accompany this kind of agriculture on steep slopes and in areas of torrential rainfall. But its overall magnitude and long-term implications are, perhaps, a different question.

In Puerto Rico, for example, shifting cultivation has been cited as a serious cause of sedimentation into valuable reservoirs. But a quantitative analysis by the United States Soil Conservation Service (Noll, 1953) of silting into the Caonillas Reservoir in Puerto Rico indicates an annual loss of only about 0.024 inch (0.065 centimeter) of soil on the watershed. This rate of erosion would mean an ultimate reservoir life of approximately 800 years— longer than can be expected in many areas of more gentle climate and less spectacular cultivation problems. There, as elsewhere, the most serious erosion per acre came from clean-cultivated

lands. At the time of the survey these occupied only 3 percent of the watershed, but produced 23 percent of the soil loss. Coffee lands, occupying 26 percent of the area, produced 40 percent of the loss. Noll suggests that this erosion can be greatly reduced by maintaining the vegetative cover underneath the coffee trees. Unimproved pastures, occupying 37 percent of the watershed area, produced 21 percent of the soil loss; and brushy forests, occupying 26 percent of the area, produced 14 percent of the loss. In order to minimize soil erosion and land deterioration, Noll recommends improved management of the coffee lands, pasture improvement by fertilization and other means; conservation treatment of the cultivated land; a grassland type of farming, and increases in forest area. As far as possible, shifting cultivation needs to be placed under control wherever it occurs; perhaps in combination with reforestation of the cleared areas by some system such as the taungya method.

Summary

In both the arid and tropical humid zones, uncontrolled forest exploitation sets up obvious dangers. In arid areas, it means serious deterioration of land, the production of flashy floods, and lower summer flows. In humid areas, it means excessive rates of erosion and lowered productivity of land. Both consequences imply the need for definite policies designed to control forest exploitation: in some cases, to provide complete protection of watershed lands; in others, to permit management of forest and grazing lands to a degree which will not cause deterioration below the critical level. In arid regions, the primary aim of such protection and management should be the control of water yields and the attainment of maximum soil stability. In tropical humid regions, the corresponding objectives should be the enhancement of land productivity, together with the reduction of soil erosion to a reasonable level.

In both zones, wherever watershed problems are of sufficient importance, policies for forest protection and management should be dominated by the ideas of optimum forest density. Where flood control and soil stabilization are of crucial importance, this optimum density may be the maximum obtainable through complete protection or the most careful manipulation of forest cover. Where soils are stable, rainfall and water yields are low, and the attainment of maximum water yields is of critical importance, the optimum density of forest vegetation may be substantially lower than that desired for maximum timber production. There the objective would be to maintain the thinnest possible stand of timber compatible with maintaining a stable watershed. In some areas, this objective might even be reached by complete removal of the timber and substitution of a good cover of range forage or of shrubs.

It should be particularly emphasized, however, that much of this fabric of conclusions and recommendations is based upon extrapolation of existing knowledge, obtained largely in the temperate zones. Throughout the arid and tropical humid zones of the world there is a great need for quantitative research and pilot-plant projects designed to work out the optimum methods of management for forest and range watershed lands.

Until such research has been successfully carried through, it will continue to be difficult for a land manager or a policy-maker to assess the relative values of protection as compared to reasonable management, or even to decide what constitutes reasonable management.

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Forestry and Forest Research in the Federation of Malaya

A Problem Analysis

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At the FAO International Seminar for Forest Research Workers held at Dehra Dun, India, in 1955,[1] all participants were requested to produce an analysis of the forestry problems of their countries. Forest services which are in the process of developing their research programs may wish to consider this digest of the Malayan problem analysis for possible adaptation to their own needs.

The analysis briefly describes the problems which confront the Forest Department of the Federation of Malaya. According to government policy, the Department is responsible, under statute law, for the control of practically all forests and forest produce. The solution of problems involved in carrying out this responsibility requires careful, systematic research which is here outlined.

Part one of the problem analysis prepared for Malaya comprises basic data on the country, making up almost half the report, and grouped as follows:

1. general information: situation and composition, political format, people and population, economy and land status, geology, climate and recent history;
2. the forest estate covers: area, ownership, reservation, protection and productive forest, accessibility, surveys, forest composition, silvicultural characteristics, silvicultural system, management, exploitation and yield, revenue and expenditure, and legal status;
3. forest industries, local consumption and markets;
4. the Forest Department organization;
5. forest research organization: publications including Malayan forest records, *The Malayan Forester*, Malayan research pamphlets; the forest school.

The Problems

Policy

In a country like Malaya, which still has 70 percent of its area under forest, it is reasonable to assume that the Government will continue to accept the policy that sufficient land should be retained under permanent productive forest to enable the estimated future demand for forest produce to be satisfied with an intensity of management that gives the highest returns per unit cost.

In planning to implement such a policy, it is necessary to make certain basic assumptions which must, however, be constantly reviewed in the light of experience or the results of experiments. The main assumptions made here are: that the population will continue to increase until it reaches about 28.5 million, or 217 per square kilometer, in 80 years time; that the consumption of saw timber per head will rise during the same period from the 1954 figure of 0.16 cubic meters round true measure to 0.28 cubic meters (the present consumption in the United Kingdom); and that the most economic method of forest management in Malaya is the present silvicultural system. Under this system, it is estimated that the present yield of 35 cubic meters per hectare obtained from virgin forest will be increased to 175 cubic meters per hectare from properly managed regenerated forest in 70 years' time. Thus an annual coupe of 46,136 hectares will be needed to produce the required future annual yield of 8,017,000 cubic meters (i.e., 0.28 cubic meter each for 28.5 million people). For sustained yield on a 70-year rotation basis, this requires nearly 3,327,600 hectares or about 32,375 square kilometers (25 percent of the country), of productive forest reserve as compared with the 1954 total of 20,720 square kilometers. Since about 68,635 square kilometers of unalienated and unreserved State land remain below the 300-meter contour, it should be possible to reserve the additional 11,655 square kilometers and still leave ample land to supply the needs of agricultural and other expansion.

In order that the full production of 8,071,000 cubic meters per annum may be available at the earliest possible date, it will be necessary to increase the present forest reserve annual coupe, to be exploited and regenerated, to 46,136 hectares as soon as possible, and at the same time to reduce output from unreserved State land to avoid overproduction in the early years. (This State land production will be required later.) This cannot be done without considerable increase in expenditure, not only on silvicultural operations (estimated to cost $74 per hectare at present rates) but also

[1] See *Unasylva*, Volume 10, Number 1, page 34. It is regretted that Mr F. H. Landon has died on service in Malaya since this paper was written.

on administration, research, traveling and the increased staff necessary to supervise work on this scale. A provisional estimate of the amount required annually is $3.4 million for silvicultural work and $6 million for other items, making a total $9.4 million compared with $4.8 million in 1954. By the time this total is reached, however, it is likely that annual revenue will have risen to at least $13 million from $10.8 million in 1954, which, it is estimated, will still leave a substantial surplus.

It will be a matter of policy for the Government to decide whether the goal of ultimate self-sufficiency in forest produce justifies the allotment of the additional 11,655 square kilometers to permanent productive forest and the investment of a higher proportion of the revenue into its regeneration. Having advised the Government on policy, it will be the task of the Forest Department — once the Government's decision is made — to make the best possible use of the forest areas and financial resources allotted to it. However, even if the Government does allocate the forest and finance necessary to permit a forest reserve annual coupe of 46,136 hectares, it must be emphasized that there will still be a gap between the saw-timber demand and the forest reserve production before the first of the new high-yielding regenerated crops becomes ready for harvesting about the year AD. 2025. This is demonstrated in the following Table:

TABLE 1. — ESTIMATED SCALE OF PRODUCTION AND CONSUMPTION, 1955-2025

Year	Estimated population	Consumption per head	Saw-timber demand	Forest Reserve production at 35m³ per ha.
		....in cubic meters....		
1955	6 000 000	0.16	934 560	566 440
1980	12 000 000	0.20	2 378 880	1 614 240
1995	18 500 000	0.23	4 078 080	1 614 240
2010	24 000 000	0.25	6 117 120	1 614 240
2025	27 500 000	0.28	7 788 000	[1] 4 446 240

[1] Includes 20,235 ha. at 175 m³ per ha.

This Table does not take into account the requirements of Singapore, which will intensify the shortage. It is likely, however, that the timber production from unreserved State land forest, together with the more intensive utilization of existing virgin forest in both State land and forest reserve, will be able — as is the case now — to make good the deficit until the end of the century. The prospects for the last 25 years of the rotation period are, however, distinctly doubtful and will continue serious unless the present annual coupe is quickly increased to the required 46,136 hectares. It may well be that, during this period, the country will have to import timber.

Basic problems

The basic problems may therefore be phrased as two questions. How may the greatest possible amount of economic timber be produced in the shortest possible time under a sustained yield system, having regard to the Government's policy on land and finance? How may the total timber produced be used to the best possible advantage?

To answer the first problem, the following factors, among others, must be assessed:

1. Whether the present yield from virgin forest can be improved by silvicultural treatment prior to felling, by better exploitation techniques or by more intensive utilization.
2. Whether the new crops grown under the present silvicultural system can be economically improved in terms of composition, quantity (i.e., the volume of saw timber produced at any given time), and rate of growth — by means of silvicultural treatment, intermediate fellings, etc.
3. Whether, with the finance available, the yield of the natural forests can be supplemented by that of fast growing exotic plantations; and whether these plantations can be established on land which is regarded as useless for other purposes, e.g., on degraded soils not suitable for permanent agriculture.
4. Whether the effective yield of the forest can be improved by preventing the losses which occur prior to felling through natural causes, such as insect and fungal attack.

The assessment of these factors lies within several fields of research: silviculture, botany, ecology, soil science, mensuration, forest engineering, forest entomology and forest pathology, for example.

The answer to the second question requires the assessment of further factors:

1. Whether uses can be found for the timber grown in the forest which, for various reasons, is not at present utilized.
2. Whether, in its constructional and manufactured uses, the timber yield is utilized in the best and most economical fashion.
3. Whether the waste of timber which occurs after felling can be avoided by better sawmill practices and by preventing the losses caused by insects, fungal decay and such agencies as technical misuse.

In these cases, the assessment of the factors lies in the research fields of chemistry, entomology and timber research.

The research required to assess all the above factors, and the many corollary problems which they bring in their trail, is described in more detail in the sections below.

Research Program

It is now possible to outline a program of projects which are required to answer the questions posed by the basic problems; it is arranged under the main heads of research. Past and current practice and future needs are also discussed.

Botany

Outline of program. The recognition of species is an essential for all silvicultural work. The two main requirements of the Botanical Branch are:

a) To identify specimens submitted to it. For this purpose the study of systematic botany and the development of a reference herbarium are necessary.

b) To publish descriptions and card keys by means of which species can be recognized in the field at all stages of their development. This requires intensive study of the leaf and bark characters of trees of all ages, and the standardization of the terminology used in describing these characters.

Past and current progress. A herbarium, started in 1918, has been built up to nearly 50,000 mounted specimens, besides numerous bark specimens. About 3,000 Malayan woody species are now known and it is unlikely that any more timber-yielding species remain to be discovered. There is good liaison with the Singapore Botanic Gardens, with *Flora Malesiana* and with the Borneon territories. An arboretum contains what is probably the best collection of Dipterocarp species in the world. Publications include an illustrated general book on *Malayan Commercial Timber Trees* (M.F.R. No. 3);[2] an authoritative *Manual of Malayan Dipterocarps* with keys based on field characters (M.F.R. No. 16); a check list of the 500 to 600 tree species reaching timber size, giving botanical, vernacular and timber names, habitat, distribution and position in the canopy; and descriptions of all known timber species in six other important families (M.R.P. Nos. 1 to 16). Descriptions of other families of commercial importance are being prepared with a view to the publication of a *Forester's Manual of Non-Dipterocarp Families.* Numerous articles have been published in the *Malayan Forester* during the last 25 years, including a recent one introducing a standardized system of nomenclature for bole and bark characters, while a form of field collecting label has been produced, with Malay vernacular equivalents, carefully planned to elicit the maximum of information from collectors regarding field characters. The forest botanist has also done a great deal of ecological work, but this is discussed in the next section.

The authorized staff is one forest botanist, one assistant forest botanist, two research assistants and three plant collectors.

[2] M.F.R. denotes the series entitled Malayan Forest Records; M.R.P. that of Malayan Research Pamphlets.

Future needs. The needs are:

1. the completion of the descriptions of the non-dipterocarp commercial families;
2. the preparation of a punch card key to timber species based on field characters;
3. the description of the less important tree families.

The authorized staff is sufficient provided that the posts are kept filled.

Ecology and soil science

Outline of program. Ecology and soil science are considered together because soil science is most unlikely to become a separate branch of forest research in Malaya. It will be a most important tool for the ecologist and silviculturist, but fundamental research on soils will continue to be more in the province of the Department of Agriculture. The work of the ecologist should be designed to assist the silviculturist in the choice of forest strata and of species. To do this he must:

a) study the composition and structure of natural forest and define vegetation types;

b) study succession after the original vegetation has been removed or modified;

c) study and define sites in terms of soil and other environmental factors which affect forest growth potential, so that they may be recognized at various stages of vegetational succession;

d) study the adaptability of species to various site conditions;

e) study which species and methods may best be used to accelerate the restoration of degraded land to productive forest.

Past and current progress. The Malayan climate is so favorable to forest growth that almost any soil may, given time, support a luxuriant vegetation, and the general structure of virgin forest throughout the country is remarkably similar. Within this framework, however, species are so numerous and variations so kaleidoscopic that chance differences between one square chain and the next, or one acre and the next, tend to obscure the fundamental site differences. A provisional classification of Malayan soils has been made by the soils chemist of the Rubber Research Institute and this classification has been tabulated and annotated by the silviculturist as an aid to their recognition in the forest. Nevertheless, progress in the recognition of sites and detailed vegetation types has been disappointing. The main vegetation types, however, have been described in Malayan Forest Record No. 16 and in recent articles by the forest botanist in the *Malayan Nature Journal*, while a number of studies of succession in secondary growth have been published in the *Malayan Forester.* The structure and composition of virgin forest, and its growth, ingrowth and mortality, are being studied in 2-hectare sample plots.

In the absence of a full time ecologist, forest ecological work has hitherto been done by the forest botanist; but recently an ecologist has been appointed under the Commonwealth Development and Welfare Scheme with the special task of evolving methods of reclamation of degraded soils.

Future needs. Intensive work is required on the objectives outlined above, especially on the recognition of vegetation types and their correlation with soils. The forest botanist in the past could never spare sufficient time for this and a recent change of staff has made the position worse. The newly appointed ecologist is working full time on the restoration of degraded land. The need, therefore, is for a new permanent appointment of a forest ecologist.

Silviculture

Outline of program. Silviculture is very closely related to ecology on the one hand and to forest mensuration on the other. Working together, these three branches must provide the answer to the basic problem stated above, by determining whether silviculture may:

1. improve the yield from virgin forest by pretreatment;
2. improve the quality and yield of regenerated forests;
3. supplement the yield of natural forest by the economic establishment of fast growing exotic plantations.

Before much progress can be made, the silviculturist must become familiar with his treatment techniques and the habits of living plants.

The more important projects may therefore be outlined as follows, (*a*) to (*f*) being basic and (*g*) to (*j*) applied:

a) summarizing past experience and existing knowledge of Malayan silviculture;
b) study of recruitment and survival of natural seedlings;
c) study of silvicultural characteristics and requirements of trees at all stages of development;
d) discovery of the best means of getting rid of unwanted growth;
e) improvement of nursery technique;
f) testing the suitability of local and exotic species for planting and the best methods of establishing plantations under different conditions;
g) establishing trial plantations, with costings, using species and methods which have shown promise in preliminary trials;
h) devising and testing techniques for the pretreatment of virgin stands with a view to increasing their outturn when they become due for felling;
i) testing the effects of various treatments on the composition and stocking of young stands during the period of establishment;
j) testing the effects of various treatments on the increment and intermediate yields of established regenerated stands.

Past and current progress. Malaya has led the world in many aspects of tropical rain forest silviculture, and particularly in the conversion of virgin jungle to more or less even-aged stands of far greater potential value. Before the war, a technique had been developed and was being applied on an increasing commercial scale, whereby the useless or less valuable trees were removed by poison-girdling, by sale as firewood, or latterly by sale as timber, while a new crop was raised under the shelter of the remaining valuable trees until the latter were harvested as a "final felling". Numerous articles in the *Malayan Forester* and the first chapter of the *Manual of Silviculture* trace the development of the system. Economic considerations, including such factors as the increasing use of mechanized methods in extraction techniques and the replacement of the hand-sawyer by sawmills, have since compelled the adoption of the simpler system referred to above and described in detail in a paper entitled *The Silviculture of Lowland Dipterocarp Forest* submitted to the 1952 Commonwealth Forestry Conference. Hence projects (*h*), (*i*) and (*j*) are new problems, and little progress on them has been made to date. Progress on the other projects may be summarized as follows:

a) The silviculturist has spent much time during the last few years on the compilation of all available information regarding the inland lowland forests. The results have been published as Parts 1, 3 and 4 of the *Manual of Malayan Silviculture* in Research Pamphlet No. 14, which deals with the *History of Malayan Silviculture, Natural Regeneration and Artificial Regeneration.*

b) Studies of the development of seedlings in scattered quadrats have been published in various volumes of the *Malayan Forester.* Milliacre (400 hectare) surveys of seedling regeneration are done in many cases before exploitation and results are being collected for compilation. There is only one permanent plot in inland forest for the study of mortality and recruitment in transects of milliacre (400 hectare) quadrats.

c) Much information is available in silvicultural files and the pages of the *Malayan Forester* on the characteristics of the more important species, and this is being assembled with a view to publication. Many other species which are now accepted, as timber have not yet been sufficiently studied.

d) Malaya led the way in the early 1930's in the large-scale use of sodium arsenite solution applied to frill girdles for the elimination of unwanted trees, and many tons of this poison have been used without casualties. A safer arboricide would, however, avoid much anxiety and the necessarily very stringent precautions. Experiments with other arboricides have been disappointing, but trials of the more promising

245-T are now being made on trees, climbers and other weeds.

e) Information about nursery techniques is included in the *Manual of Silviculture* referred to above, but has not been published separately.

f) The experimental plantations at the Research Institute now cover over 200 hectares and some are nearly 30 years old. Small-scale trials of exotics have been actively pursued during recent years, most indigenous species of value having been found difficult and expensive to establish on poor soils or in exposed conditions. The latest summary of trials with exotics was published in Volume XVI of the *Malayan Forester*.

g) One of the fastest growing exotics, *Albizzia falcata*, which after a test was reported to be suitable for paper pulp, was chosen in 1954 for an 8-hectare fire-protected plantation in *Imperata* grass. Further experiments in planting open or degraded areas have been entrusted to the ecologist appointed under the Commonwealth Development Scheme.

The silviculturist is assisted by a plantations officer and field staff in charge of the experimental plantations; and by a mobile research team of four, who can assist with experimental work in any part of the country and who also help with records and mensuration work.

Future needs. Continued work is necessary in all the basic projects (*a*) to (*f*), but more particularly in the study of the silvicultural characteristics of the lesser known species and the finding of a safe and economic arboricide. Projects (*h*) to (j) need planning from the start. No details are given here because the technique of measuring and comparing the effect of different treatments on such mixed rain forest stands has not yet been worked out. The problems will be discussed under the heading " mensuration " in the next section.

The silviculturist holds a key position in research but, in recent years, working-single handed, he has tended to be bogged down by routine work and the necessity for consolidating and making available past experience. With so much new work to be done, a fully-qualified assistant silviculturist is now a necessity.

Forest mensuration

Outline of program. As stated above, the forest mensuration program is closely allied to the silvicultural programme. The main mensuration projects are therefore as follows:

1. compilation and analysis of all existing sample plot data on the girth, basal area and volume increment of each species so far studied, or of various combinations of species, and the effects of various treatments on them;
2. construction of commercial volume tables based on two independent variables (basal area recorded in units of girth and clear bole height) for the main commercial species or, wherever possible, main groups of species;
3. design of a sampling scheme to investigate the composition and structure of existing regenerated forest; this will be followed by the execution of the scheme and the analysis of the results;
4. design of a permanent sample plot layout (in which the data to be recorded and the methods of analysis to be used will be specified) to investigate the effect of various silvicultural treatments on the increment [3] and potential commercial yield of:
   - *a*) virgin forest prior to felling,
   - *b*) the young regeneration from the year ' n ', when the old crop was felled, to the year ' n plus 10 ' – the " establishment " period,
   - *c*) the established regenerated crop between the year ' n plus 10 ' and maturity,
   - *d*) exotic plantations.

The Mensuration Branch will also assist the Silvicultural Branch in the execution of these designs and will analyze the data collected.

In all the above studies, very close liaison with the Silvicultural Branch will be maintained.

Past and current progress. The first sample plots were laid out in 1901, but the present series was not started until 1916. Since 1916, 381 sample plots have been laid out. Of this number, 34 contain no increment data and all records of 59 were destroyed during the 1939-45 war. The remainder contain the annual measurements (and other observations) of approximately 25,000 trees of 230 different species, although the majority of measurements have been made on the relatively few chief commercial species under varying conditions and treatments. These measurements have been made over varying lengths of time up to 39 years.

The first compilation of all inland forest sample plot data was made in 1928 and published as M.F.R. No. 9 *The Growth of Malayan Forest Trees as shown by Sample Plot Records, 1915-1928.* A second compilation had just been completed in 1941 when the invasion of Malaya took place. The whole of the second compilation and all the detailed work of the first were destroyed during the Occupation period. A fresh start on the compilation of all data collected since 1916 was therefore made in 1952, but subsequent progress has been slow.

Various volume tables were constructed prewar and published in the *Malayan Forester.* They were nearly all based on one independent variable (g.b.h.) only. Unfortunately, all the felled tree volume data on which they were based were destroyed during the war. The collection of fresh data was started again in 1947 and, by the end of 1954, the detailed measurements of some

[3] No Malayan tree species has annual rings which can be correlated with annual growth.

7,000 felled trees had been obtained. The construction of the first new volume tables (for the two most common *Shorea* spp.) is now in progress.

The preliminary draft scheme for the sampling of the regenerated forests has already been considered by the Advisory Research Committee. A final scheme is now in course of preparation.

The draft rules for the layout and collection of data from silvicultural treatment plots have been formulated and given provisional approval but some addenda are required. A series of investigations have been made to discover the best methods of analysing the data collected from permanent sample plots in mixed, uneven-aged forest without growth rings, but the results achieved to date have been inconclusive.

The present authorized staff consists of one forest mensuration officer and one research assistant, but both these posts are now vacant.

Future needs. With regard to project 1, it is probable that this alone would occupy the undivided attention of one research officer and one assistant for a period of not less than two years. Project 2 depends for its progress on the rate of collection of the field data, but the first new volume tables could be constructed now if an officer were available for the work. Projects 3 and 4 also require the undivided attention of a qualified officer with computing staff.

If work on all four projects is to progress concurrently, the best solution would be the appointment of officers qualified in the use of statistics for specified projects only, each for a period sufficient to complete the project concerned, e.g., one officer for project 1 and, perhaps, project 2, and another for projects 3 and 4. A common staff of computing assistants could perhaps be used by both officers. Once projects 1 and 3 had been completed, it would be possible for one officer with two assistants to continue the work required.

Other research branches

Other research branches, though equally important, will not be discussed in detail in this study, their activities being similar the world over. The following paragraphs are explanatory of some local applications.

Entomology and pathology. The entomologist is working on the life history of pests, protection of plantations from insect attack, and the protection of timber at all stages from stump to ultimate use. In the past, special attention has been paid to the attacks of Ambrosia beetles, and a number of papers have been published on this subject.

There is no pathologist, protection against fungi being dealt with by the Timber Research Branch. There is one important problem under this head, however, that of "spongy heart" or "brittle heart" which causes serious degrade to the living trees of the two commonest light hardwood species, *Shorea parvifolia* and *S. leprosula*, especially the former in which the loss may amount to 30 to 50 percent. It is not known whether the degrade is due to fungal attack, to stresses in the living tree or to some other cause. It is possible that some factor such as soil deficiency may be a predisposing influence. At present the wood technologist is working on the problem.

Timber research. The objectives of this Branch are:

1. to make supplies of timber last longer and go further by proper seasoning and preservation methods, correct design and economy in dimensions used;
2. to find means of using timbers that are at present unsaleable.

It carries out tests of mechanical properties according to the standard international procedure for 2-inch square specimens and the results, published in the manuals of dipterocarp and non-dipterocarp timbers and in timber trade leaflets, have made possible the use of smaller dimensions and substitute timbers. Nevertheless, a lot remains to be done because the air-dry stocks of many important timbers that had been tested only in a green condition were either lost or destroyed during the war. A new development is the Composite Wood Section, which will test the veneering and glueing properties of Malayan timbers.

Chemistry. A new Branch has started the study of the pulping properties for hardboard and paper manufacture of such sources of supply as mixed hardwoods, plantation species, rubber wood, bamboos, *Imperata* grass and rice straw. From the departmental point of view, the aim is to find uses for the large quantities of crown and branch wood of commercial species which are at present left to rot in the forest; and for the uneconomic tree species which do not attain 1 to 2 meters g.b.h. and are at present poisoned.

Research under the Conservator of Forests, Utilization. The departmental Branches under the control of the Conservator of Forests, Utilization, are shown in the Table. Broadly the research studies undertaken by these Branches may be listed as follows:

a) improvement of extraction techniques;
b) improvement of sawmilling procedure;
c) constructional uses of timber;
d) marketing research.

Under *a*), in conjunction with manufacturers' agents, trials are held of modern extraction equipment and demonstrations made to the logging industry. A recent trial was made of the Swiss-made Wyssen self-moving winch, which has aroused such interest in Europe. However, the manufacturers believe, on the strength of these trials, that modifications are necessary before it would be suitable for Malayan conditions.

Research under heads *b*) and *c*) is carried out in conjunction with the Timber Research Branch but on an applied scale. The forest engineer, under the Conservator of Forests, Utilization, has to approve all Malayan

sawmill designs and often constructs the plans himself. In conjunction with the Timber Research Branch, the correct uses of Malayan timbers in constructional design have been published in M.F.R. No. 13 (now under revision), and in diagrammatic leaflets. Termite-proofing techniques have been tested and published. A recent development was the full-size construction of a cheap housing unit using preserved secondary timbers and designed to sell at a basic cost of $ (Malayan) 2,300.

Under head *d*), the Timber Purchase Branch, in conjunction with the forest officer at Singapore, has been responsible for the Malayan grading rules for sawn timber. FAO has recommended that these rules should be adopted as a basis for the formulation of all such rules in Far Eastern and Pacific countries. This branch also runs timber depots for the purchase, sorting, grading, seasoning, preservation and sale of local timbers. At present, the problem of marketing secondary, less well-known timbers is having its attention. The solution of this problem may well be bound up with the construction of the cheap housing units mentioned above.

The *Research Programme of the Malayan Forest Research Institute*, containing details of all the projects of the various branches, was published as Malayan Research Pamphlet No. 15 in 1954 and the *Research Progress Report for 1954* as M.R.P. No. 15 A in 1955.

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Hanunóo Agriculture

An Example of Shifting Cultivation in the Philippines

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These photographs, taken by the writer in 1953, illustrate some of the principal stages in shifting cultivation as practised by the Hanunóo, a group of upland farmers on Mindoro Island in the Philippines. A detailed study is shortly to be published as part of an FAO Forestry Division special series of studies.

A new half-hectare plot of preferably mature second growth forest is cleared annually with knife, axe and fire by each Hanunóo family. Such fields are dispersed and must be fenced, weeded and guarded during the first six months of the cultivation period. New areas are cut only within easy walking distance of one of the small hamlet-like settlements in which five or six family households live.

Rice, maize, bananas, yams and sweet potatoes are the main staples grown, but a total of more than 80 other crops are interplanted in the forest clearings of these mountain folk.

Figure 2. *Planting root crops (March). A woman using a digging stick to plant taro sets in a cut, but unburned field. Such root crops survive later burning.*

Assisted by favorable climatic conditions and an intimate knowledge of the local flora, the Hanunóo have farmed the same forest region by 'field rotation' for many generations.

Figure 1. *Felling (early spring).*

Figure 3. *Firing (April). This upland farmer moves through a protective fire path with a dried cracked bamboo torch.*

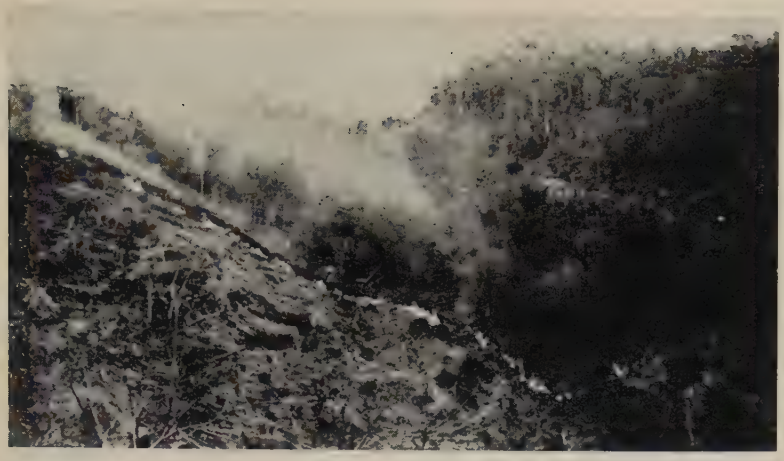

FIGURE 4. *A large clearing beginning to burn (April). Flames consume the dried second growth forest debris over the entire plot in less than an hour.*

FIGURE 5. *A neatly fenced, well-burned field (May). Fences are required because of domestic cattle and wild animals; poles left standing serve as climbing posts for yam vines and later as firewood.*

FIGURE 6. *Seeding rice (June). The seeder is about to drop a small handful of rice mixed with seeds of certain other food plants into a dibble hole made by her father.*

FIGURE 7. *Weeding (July). Rice, maize, cassava, pigeon peas, and banana plants are visible in this field which is being cleaned for the second time.*

FIGURE 8. *Eating rice and bananas. A nuclear family enjoying a midday meal of two kinds of starch staple from a basketry tray. Side dishes include boiled vegetables and small fish.*

A Forest Inventory in Thailand

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Chief of the Forest Inventory Section, Forest Research Institute, Reinbek, Germany

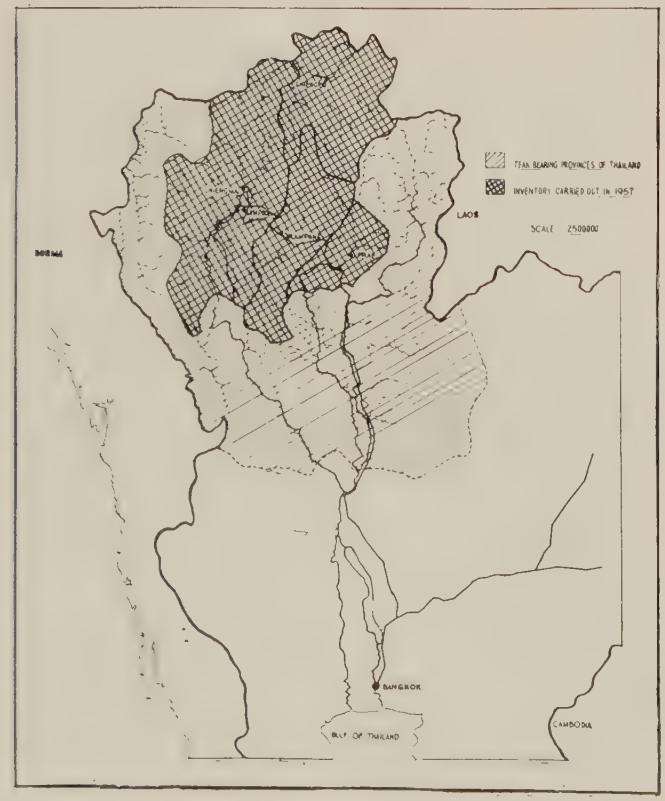
The method described in this paper was developed in 1955 during an assignment to carry out an inventory of the northern teak-bearing provinces of Thailand. The most important features here are that teak occurs scattered among other species of the mixed deciduous forest which has rather a low stock per unit area, and communications to the mountainous forests are generally very poor. It is evident that conditions will differ in other tropical countries where different methods may have to be evolved, and this paper only gives an example of an effort to deal with the present conditions of the forests in Thailand.

The census started in 1956 and the results for five of the provinces representing the heart of the Thai teak-bearing area (see Figure 1) and yielding about 60 percent of the Thai teak were completed in June 1957 and are being isued this year.

Sampling Design on the Aerial Photographs

The photographs were taken in January 1953 on an average scale of 1 : 48,000 for the area below 1,000 meters above sea level. Teak does not generally occur above 1,000 meters so that contour line of 1,000 meters was marked on all of the photographs of the Northern Provinces, thus dividing the area into two main parts - below and above 1,000 meters above sea level. The sampling technique aimed at determining the proportions of the area of the strata recognizable on the photographs.

Figure 1. *Teak-bearing provinces of Thailand.*



The following strata can be recognized from the photographs:

Below one thousand meters

a) *Mixed deciduous forest.* This is the teak-bearing type of forest. There is however, a rather high percentage of the area under this type which does not contain any teak white in the real teak-bearing part, teak seldom occurs in pure stands but is scattered amongst other species. Unfortunately the bulk of the photographs were not taken during the flowering season of teak (August/September). On some photographs (see Figure 2) taken at this time it is possible to distinguish between the substrata " teak-bearing " and " non-teak-bearing " mixed deciduous.

b) *Semi-evergreen.* The big trees of the species *Hopea* and *Dipterocarpus alatus* can clearly be recognized as white spots even on the small-scale photographs.

c) *Dry dipterocarp type.* A rather poor and low forest, but important for production of fuelwood. Severely overworked areas of this type can clearly be distinguished from old clearing or secondgrowths. Both of the latter strata do not contain any big trees, but they differ from each other in the tint of the ground on the photograph. The old clearings were originally mostly of mixed deciduous forest type.

d) *Permanent non-forested area.*

Above one thousand meters

At this elevation the forest is inaccessible and mostly of hill evergreen type or savanna forests, mixed with some conifers on the mountains and semievergreen forests along the valleys. These forests being of importance for the water supply of the country, the degree of destruction inflicted by the numerous hill tribes (shifting cultivation and annual burning) needed to be estimated; this could be indicated by the special stratum " old clearing above 1,000 meters ".

To obtain the area of the above-mentioned strata, their percentage is sampled photograph by photograph by a suitable design to arrive at a sound average percentage for each province. The percentage can

FIGURE 2. *Two girdled and dead teak trees. In the background is a flowering teak.*

be changed into superficial measures, by assuming the official figures for area of the provinces as 100 percent.

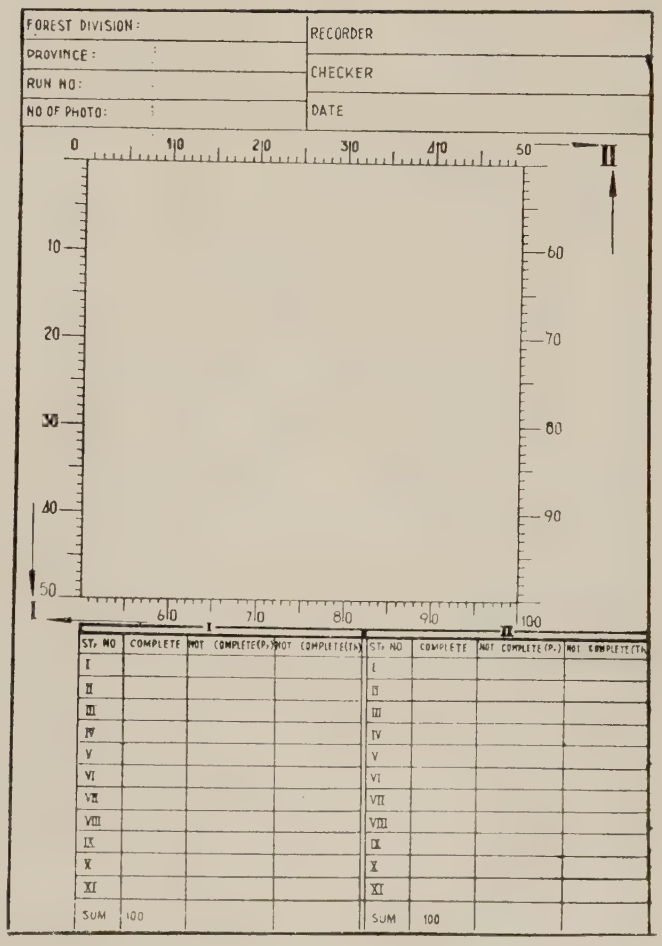
The sampling design itself follows the idea of the tract-line-system; because the dot-grid-system as well as the delineation system inside special sample plots on the photographs was not found satisfactory owing to the small scale of the photographs.

The tract-line system consists of a square, 5.0 × 5.0 centimeters, which means approximately 2.5 kilometers for a scale of 1: 48,000, and which is transferred by photographing on a plate of glass. Each millimeter as well as centimeter is marked by dashes. This design is also printed on a form to be used as a record for each photograph (see Figure 3). The interpreter puts the glass design on the photograph to be sampled so that the point " 75 " of block II as indicated in Figure 3 lies exactly on the principal point (center) of the reference photograph. To facilitate this, the glass is prepared in the same size as the photograph itself (23 × 23 centimeters) and a line cross is laid out on the principal point, in a north/south and east/west direction up to the margin of the glass. Thus, the interpreter needs only to put the cross on the fiducial marks on the margin of each photograph.

The principal point of the photograph is not identical with the center of the sampling tract. This is necessary in order to avoid any double sampling because of the 60 percent overlap if every photograph is sampled.

The interpreter uses the mirror stereoscope and the four-fold magnifier and follows the line of the square. On the design of the form given in Figure 3, he marks boundaries between the strata mentioned above. Fin-

FIGURE 3. *A form for a tract-line system.*



ally, he adds the millimeter belonging to each stratum and puts the totals on the corresponding columns as shown in Figure 3 below the "square". The sum of millimeters (or percents) must be 100 for each block (two sides of the square). The sub-dividing of the tract into two blocks is necessary for the analysis of variance. It should be mentioned, that biased errors occurring from any wrong interpretation can be avoided only by very careful checking and proper training of the interpreters in the field. The daily work of one interpreter is about five photographs.

After having finished five provinces, statistical investigations are made to decide whether it is necessary to sample every photograph. The sampling of every second or third photograph may be sufficient to produce satisfactory results. Photograph sampling is the least expensive part of the census and, therefore, the greatest accuracy should be aimed at.

Field Sampling

Field sampling aims at obtaining the essential data of the growing stock of the different strata. There are two main difficulties

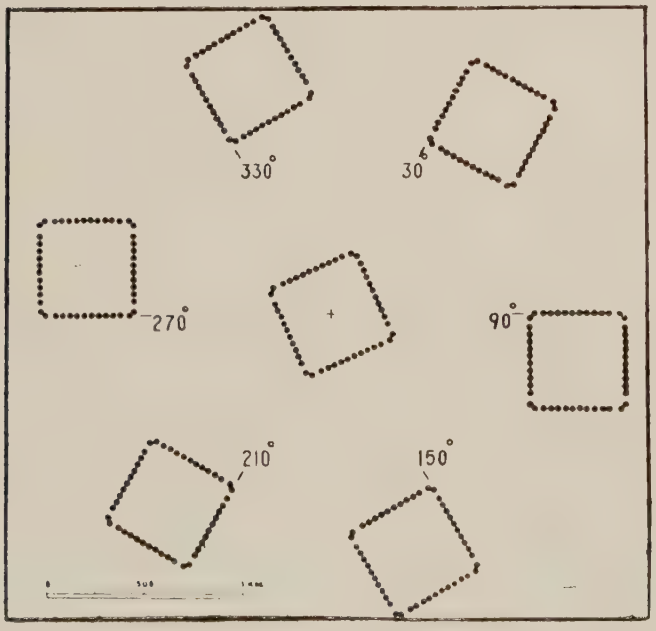
(*a*) lack of staff able to make independent decisions in the field;

(*b*) the mountainous, often hardly accessible terrain of north Thailand.

To cope with the first difficulty the sampling system must be sufficiently clear-cut, based on routine work and must not leave any room for independent decisions by the field staff. The less accessible terrain requires from the point of view of economy that work in any particular plot be completed in a day.

These considerations have led to the so-called camp-unit-system now used in Thailand. The basis of this system is the circular sample plot of 0.05 hectare (radius 12.61 meters). The arrangement of the sample plots in the field will be carried out as follows:

Figure 4. *A camp unit.*



One crew should consist of two officers and two workers. The daily work of one crew should be 48 sample plots arranged along one tract. One camp's staff consists of seven crews, thus the daily work of one camp yields 7 tracts, or one "unit". Details about the arrangement of the tracts and the sample plots inside the tracts are shown in Figure 4.

It is obvious that everything becomes a matter of routine as soon as the staff has reached the center of the unit because every crew leader knows his bearing leading to the beginning corner of the tract as well as the corresponding distances from the center to the tract and from sample plot to sample plot (Figure 4).

The unit centers have to be found first on the photograph, and later located in the field. To standardize this work, the camp unit system was developed. To find the unit centers in the photograph, the design of the camp-unit is prepared on one celluloid disk which has to be fixed on the corresponding photograph so that the principal point of the photograph coincides with the center of the camp and both of the cross lines (north/south and east/west) meet the corresponding fiducial marks on the margin of the photograph.

The situation of each unit center can then be taken from the photograph which serves as a guide — through the use of a pocket stereoscope — in locating the centers in the field. If the total area of one camp is considered as a circle with a radius of 5 kilometers from the center up to the furthest sample plot, the percentage of cruise inside the camp area is 1.5 percent, because the total camp area amounts to 79 square kilometers whilst the sampled area can easily be calculated from 2,352 sample plots times 0.05 hectare which makes 1,176 square kilometers.

The selection of the photographs used as camp centers should be mentioned. The percentage of cruise aimed at is 0.1 percent (or 1:1,000) of the area below 1,000 meters above sea level. Work in the five provinces led to a sampled area of 50,568 square kilometers or 43 camps.

Out of the 1,500 photographs covering the five provinces those are omitted which fall in the area above 1,000 meters and the area covered by towns and permanent agricultural land which roughly works out to a total of about 20 percent. To obtain a systematic distribution of the camps throughout the five provinces, the remaining 1,200 photographs are subdivided into groups of 28 following the subsequent numeration of runs and photographs. Out of each group one photograph is taken at random to locate the reference camp. Thus, a restricted random distribution is used. It must be realized that by this method one biased error will arise with regard to the percentage of the area of the strata obtained by ground sampling. The non-forested area will be smaller and the area above 1,000 meters will not occur at all. But this error can easily be eliminated by use of the aerial photograph sampling described above.

To check the interpretation of the aerial photographs, a special design was developed. The camp unit design itself is placed by photography on a glass, thus enabling the supervising interpreter to interpret the photograph along the tract already sampled by fieldwork (see Figure 5).

This additional work was carried out on all of the 43 photographs used as "camps" in the field. The results have been compared with the stratification found in the field with a view to finding out the biased errors, if any.

As already mentioned, the percentage of cruise of the area of a camp is 1.5 percent, while the total area below 1,000 meters is to be sampled by a 0.1 percent cruise. It is a well-known fact that the larger the ratio between the total percentage of cruise and that of the sub-sample, the more unfavorable is the efficiency of the sampling. Here the ratio is 1 : 15. It should be mentioned that the 1.5 percent cruise inside the sub-sample seems to be the utmost concession with regard to the difficulties of the terrain. Some statistics obtained from the 43 finished "camps" may explain this.

The average working time for one tract (daily work of one crew) is about 4 hours, ranging from 3 to 6 hours according to the type of forest and the terrain. The time to walk, or as far as possible to drive by car, from the camp site to the center of each unit amounts to 77 minutes (back and forth 154 minutes or 2.5 hours) on the average. But among the 301 surveyed units, 33 percent needed 4½ hours and 5 percent even 6 hours and more walking time back and forth on the average. It is obvious that, especially under tropical conditions, the average working time of 2½ hours walk plus 4 hours survey is strenuous enough. The unavoidable exceptional cases of more than 8 hours total working time must be rewarded by an additional rest day in order not to harm the health and spoil the enthusiasm of the staff.

The practical performance of this camp-unit-system has proved satisfactory in the field (Figure 6). Two staff groups, each including a camp-leader, his aide and 14 crew officers worked independently from each other. They were supplied with strong cross-country jeeps and so were able to travel from camp to camp by car as far as the communications allowed. Sometimes buffalo carts or porters had to be hired to reach the site. On average, travelling time from camp to camp was 2 days (ranging from 1 to 6 days).

One staff completes 2 to 2.5 camp-units a month. Thus, the 43 required camps for five provinces were finished in about ten months' field work.

The question is frequently put as to why the small circular sample plot is used instead of strip system which could also be laid out in the form of a squared tract. Some advantages found under the conditions of the Thai forests may explain this.

One tract contains 48 sample-plots, 0.05 hectare each, or 2.40 hectares sampled area. The same sampled area could be obtained by a strip of 12 meters in width,

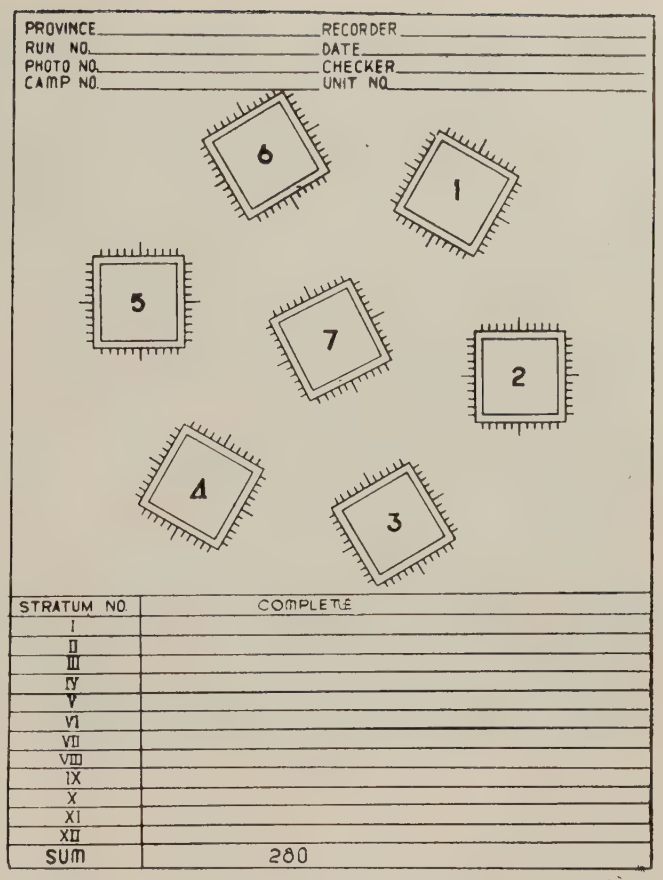


FIGURE 5. *The form used to interpret the photographs.*

holding the same length of 2 kilometers used in the tract. But it has been experienced that the determination of the limit cases (trees standing just on the boundary) can be done more exactly in measuring the distance from the center point of a circle than in drawing a perpendicular from the line.

The main preference of any small sample plot is the easy determination of the appropriate stratum in which it falls. Having uninterrupted strips, the stratification must be done by distance measurement, leading to unequal parts of the strips according to the occurrence of the different strata. This involves difficulties in recording and punching. Furthermore, the correct determination of the spot on which the readings of the distance measurement along the line should be taken needs decisions by the crew leaders, which should be avoided. On the other hand, the stratification of the single sample plots is easy even in such cases where there are two different strata in one sample plot. The predominant stratum is to be taken. Sometimes aerial photographs do not bring out all the stratifications clearly, as in the case of the photographs available for Thailand. In such cases, further subdivision of the strata distinguished in the aerial photograph has to be made in the field. For instance, the mixed deciduous type of Thailand forests has to be subdivided into teak-bearing and non-teak-bearing types.

In the field, all these sample plots fall into the teak-bearing mixed deciduous type which shows some teak

FIGURE 6. *An inventory crew working in the teak-bearing area.*

(i. e., teak trees, regeneration or stumps) within a radius of 25 meters even if, inside the measured sample plot of 0.05 hectare, teak does not occur at all. The area of the teak-bearing mixed deciduous type (= stratum 1) is obtained by taking the percentage of the total of the sample plots of stratum 1 from the total of the sample plots of mixed deciduous forest. The total area of the mixed deciduous was already obtained by the photograph sampling. This figure has to be reduced by the percentage mentioned above. This is an example for the strata area originating from the combined (ground plus photograph) sampling, the errors of which are of course higher than those from the pure photograph sampling.

Data to be measured or estimated inside the sample plots

1. *Tree species.* Seventy-two important species are coded and have to be determined, while all other occurring trees fall into a collective code. Teak, as the most important species, includes five different codes: one for the growing stock, two for teak stumps, and two for girdled trees with and without official hammermarks to obtain figures of official and illicit cuttings.

The punch-card system allows the results to be presented in any desired grouping scheme.

2. *Basal area at breast height.* For every standing tree the basal area at breast height is directly measured by the aid of "*Bitterlich's Tarifmesswinkel*". This handy instrument works satisfactorily. Three readings with a difference of 120 degrees from each other, must be taken for each tree. The readings are not made as to diameter, as usually, but in terms of basal area to facilitate the calculation work done by the punched card system (IBM). These terms of basal area are called "Wanner weights" which give the basal area in square meters multiplied by forty. The following Table shows the relation between weight, diameter and circumference:

TABLE 1. – RELATION BETWEEN WEIGHT, DIAMETER AND CIRCUMFERENCE

Diameter limit, in cm.	Circumference limit, in cm.	Wanner weight	Basal area of one tree, in square meters $= \frac{W}{40}$
12.5	39.5		
		1	0.025
21.8	68.5		
		2	0.050
28.2	88.6		
		3	0.075
33.3	104.6		
		4	0.100
37.8	118.8		

As may be seen from the tally sheet (Figure 7), all three of the readings are to be put down, but only the average figure for them (next column) will be punched.

From weight 14 and upward (diameter 67.90 centimeters) for teak a tape has to be used because of the irregular stem forms of the bigger teak trees.

3. *Merchantable volume.* The number of 5-meter logs is estimated ocularly from each tree from weight 3 and upward at breast height. In addition, the weight

of each log is obtained by estimation for which the already measured weight at breast height is a great help. For regular teak stems with a continuous clear bole a table is used with the entries " weight at breast height " and " number of 5 meter logs per tree ", which allows the direct reading of the " sum of weight of logs " for that tree.

It should be mentioned, that about 95 percent of the measured standing teak trees inside the sample plots show regular stemforms. Thus the volume of bulk of the teak was found by using this method.

A word must be said about converting the stumps, measured under bark by tape at 0.30 meter high, into basal area over bark at breast height. The relation between girth at stump height and girth at breast height over bark was obtained by measuring about 3,000 standing trees. Using double logarithmic paper, a straight line could be obtained by the method of the smallest squares. The relation between diameter under bark and diameter over bark of the Thai teak was already known.[1] Finally, the basal area over bark of the stump was converted into volume with the aid of the method mentioned above.

To convert the sum of weights of logs into merchantable volume, (Hoppus cubic meters) the following multiplication must be made: sum of weights $\times$ 1/40 (according to " Wanner weights ") $\times$ 5 (length per log) $\times$ 11/14 (Hoppus factor). The product of the last three factors makes 0.0982, or, for rapid estimates, rounded off to 0.1. Hence, the sum of weights of logs can be considered to be nearly tenfold the required merchantable volume.

4. *Additional data obtained from each sample plot.* The teak regeneration is sampled inside a concentric sample plot of 0.01 hectare. Four classes of young teak trees are formed: trees holding weights 2 and 1, then trees smaller than weight 1 at breast height but taller 1.3 meter and finally trees below 1.3 meter. The separation into " seed origin " and " coppice origin " seems to be important because trees originating from coppice origin are not likely to grow up to clear boles especially if the stump comes from an older tree. The site quality class of teak can be determined by the relation of circumference over height from predominant trees. If one big teak tree occurs inside a roughly estimated circle of 25 meters around the center of the sample plot, its height and circumference at breast height has to be measured. Thus, for the teak-bearing area as a whole, the percentage of the prevailing site quality classes will be obtained, which can serve as a help for the calculation of the growth to be expected. The diameter growth of teak is to be collected by a sufficient number of borings, for each site quality class. In addition, data are collected from each sample plot with regard to the prevailing kind of bamboo, and topographical and logging conditions.

[1] Inventory Methods for Tropical Forests, FAO ETAP Report N° 545.

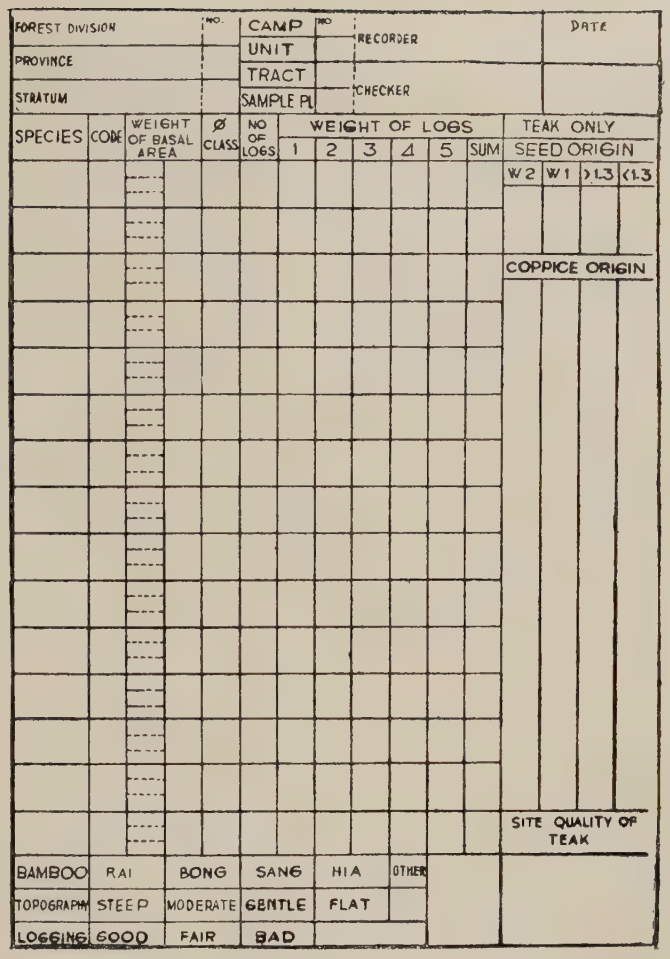


FIGURE 7. *A tally sheet for sample plots.*

PUNCH-CARD CALCULATION

The tally sheet (see Figure 7) is ready for punching. For every occurring tree a special punch card is prepared. The five provinces have yielded 100,000 tally-sheets. Every sample plot, even if there is no tree on it, is put down on a separate tally sheet. The punching and verification can be done as soon as finished camps from the field arrive at Bangkok, thus avoiding any unnecessary delay. The results are tabulated for each province and, afterwards, for the area as a whole.

DEGREE OF ACCURACY

1. *Forested area.* For strata, directly obtained from aerial photographic sampling, the sampling error can be calculated by the analysis of variance. The teak-bearing mixed deciduous forest is the most important stratum. As already explained above, a combination between ground sampling and aerial photograph sampling must be made which leads to an additional source of errors; both of the errors must be combined under the propagation of errors. The goal ($\pm$ 4 percent sampling error for 5,000 square kilometers of teak bearing mixed deciduous) could be obtained.

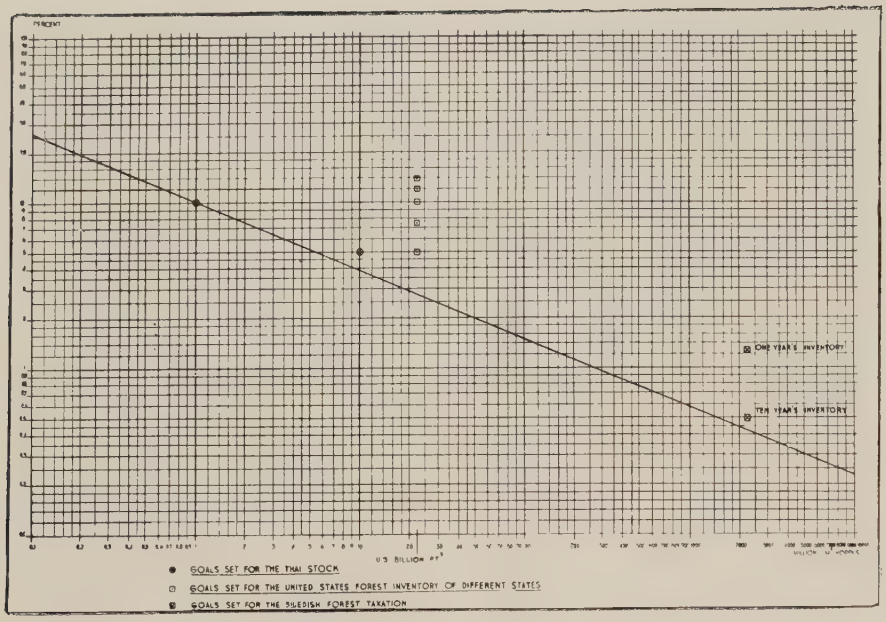


FIGURE 8. *A graph showing the percentage of sampling error for volume Hoppus of* Tectona grandis *in the Thai national forest inventory.*

2. *Growing stock.* From the ground sampling the stock per unit area of each referring stratum was obtained which is multiplied by the known area sizes of each corresponding stratum. The sampling error of the stock per unit area can be found by a special kind of analysis of variance. Using the propagation of errors, again, the final sampling error of the growing stock (see Figure 8) can be calculated. The goals (± 10 percent for 1 million cubic meters and ± 5 percent for 10 million cubic meters) could be obtained.

To illustrate the accuracy obtained for the Thai National Inventory, the goals set for the Swedish as well as for the U.S. National Inventory are marked in the appropriate figures.

COSTS OF THE INVENTORY

Costs for the Thai National Teak Inventory 1956/57 of the Provinces Lampang, Chiengmai + Lampoon, Chiengrai and Prae can be estimated as follows:

		Km²
Area:	below 1,000 meters	52,760
	above 1,000 meters	8,250
	TOTAL	61,010

		U.S. $
Teak bearing area (10,962 km²)	*per* 1 *km²*	5.03
Total forested land (43,801 km²)	,, ,,	1.28
Total area below 1,000 m. (52,760 km²)	,, ,,	1.05
Teak stock (9,216,059 m³)	*per* 1 *m³*	0.006
Total timber (102,599,200 m³)	,, ,,	0.00055

TABLE 2. – ESTIMATED COSTS OF THAI NATIONAL TEAK INVENTORY

Details	Cost in US $	Percent
Field sampling:		
Salary and perdiem for 35 officers, (= 2 field and 1 headquarter's staff) wages for 70 workers and 6 car drivers, wages for porters, mules, cost for gasoline, repairing the cars, etc.	45,259	
Cost of 3 medium and 2 small jeeps incl. trailers, U.S. $21,836 25 % = 5,459	5,459	
TOTAL	50,718	90.2
Aerial photograph sampling:		
Salary and perdiem for 4 officers	2,674	
Cost of 1,500 aerial photographs (prints)	725	
TOTAL	3,399	6.1
Punchcard calculation and wages	2,134	3.7
GRAND TOTAL	56,251	100.0

It should be taken into consideration that the Forest Inventory 1956/57 carried through by the Royal Forest Department of Thailand was the first one of its kind. A certain amount of time was taken to overcome administrative difficulties. In addition, the time necessary to train the staffs has not been eliminated from the above Table. It can be assumed that, using the experience obtained, costs for the forest inventories of Thailand of the future can be reduced by about 10 to 20 percent of the above figures.

Commodity Report

Particle Board

This report on production, consumption and trade in particle board is the first to appear in Unasylva. *Like the report on fibreboard which appeared in the last issue of* Unasylva, *it is based on a paper prepared by the FAO Secretariat for the International Board Consultation held in Geneva from 21 January to 4 February of this year. It also includes some new information submitted to the Consultation by the participants.*

Production and capacity

The particle board industry,[1] which had its inception some fifteen years ago, has been growing at a very rapid rate and has a present day production of over 1 million cubic meters (about 750,000 tons). This compares with a current output of 3 million tons, more or less equally divided between hardboard and insulation board, by the fibreboard industry, which is now over 30 years old. The particle board industry is today steadily gaining recognition as a new and definable industry; official statistics, however, are still almost completely lacking. The statistical information included in the following pages has been communicated to the Secretariat by producers, research institutes, trade associations and equipment manufacturers.

Experimental work on particle boards was carried out both in Europe and North America before the war, but the first plant to produce particle board commercially was built at Bremen during the war, in 1941. It operated on wood (spruce) chips using a phenolic resin as binder, and had a daily production of 10 tons. In the years 1941-43, two plywood factories in Germany began to manufacture wood particle boards out of plywood waste, ground or cut into small particles. They used multi-opening presses and the binder was urea resin. Work on the technical and scientific problems involved intensified in the postwar years, when Germany was confronted with a serious wood shortage. Urea resins were generally used, and it was found that considerable resin economies resulted from the use of homogeneous, engineered particles instead of heterogeneous wood chips.

Many wood species were found to be suitable including birch, beech and alder as well as pine and spruce. Developments followed in Western Germany and elsewhere, notably in Switzerland and the United Kingdom, with wood as the basic raw material for the plants established. The first three-layer particle board, with coarse wood particles forming the middle layer and thin flat particles the stronger outer layers, was marketed in Switzerland in 1945.

Meanwhile, the possibility of using agricultural residues instead of wood had been explored, and a first plant based on flax was put into operation in Belgium in 1947, to be speedily followed by a number of others using flax straw. Today, of the 195 or so particle board plants in existence, some 15 utilize flax straw, while at least two others based on this material are in the course of erection. The aggregate annual capacity of the mills based on flax is estimated at around 250,000 cubic meters. As yet no particle board mill based on wheat straw or bagasse is in operation, though a plant to utilize coconut fibre residues is reported as under development in North Celebes.

As working processes in the particle board industry improved, methods grew more rational and uses for the finished board multiplied; fabrication also started in other continents: Asia, Africa and America. In America especially the number of new factories increased and output rose rapidly.

The original installations for manufacturing particle boards were all based on the utilization of the waste or residue from other forest products manufacture, such as slabs, edgings, cutoffs, planer shavings, sawmill culls, clippings and cores from veneer manufacture, and cuttings, planer shavings and trim from furniture and millwork factories. These types of raw material are usually hammermilled to produce splinters or slivers. There is a definite trend toward the use of better engineered particles than those obtained by hammermilling, and many plants today have or are installing appropriate equipment to prepare flakes, wafers, and other special particles from roundwood. Besides being more economical of resin for a given quality of board, the engineered particles yield a board with a better surface and are held to justify the increased cost of selected raw material and particle preparation.

Additives of two types are used in the basic manufacturing process for particle board. Both are added to the particles before the board is formed into a mat or

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[1] At the International Board Consultation the following definition of particle board was recommended: a sheet material manufactured from small pieces of wood or other ligno-cellulosic materials (e. g., chips, flakes, splinters, strands, shives, etc.) agglomerated by use of an organic binder together with one or more of the following agents: heat, pressure, moisture, a catalyst, etc. (Woodwool or other particle boards with inorganic binders are excluded.)

In one or two countries (notably the United Kingdom) the commodity is known as wood chipboard. In a number of countries, however, particle board is manufactured from non-wood raw material.

sheet. A binder is a material added in manufacture to provide the bond which gives the board its form and strength. Size is added to increase water resistance. The binder, which produces the bond and glues the particles together, is the most expensive single component in a particle board. Thermo-setting synthetic resins — urea formaldehyde, phenol formaldehyde and melamine formaldehyde — are the basis for most binders for particle board. Urea-formaldehyde resin is the most widely used; it is the most economical, light colored and is suitable for boards for interior application. Phenolic and melamine resins cost more but give bonds that are resistant to more severe exposures of moisture and heat and are therefore more durable. Size for particle board is primarily paraffin wax, which is dissolved in mineral spirit or melted and sprayed on the particles. Small amounts (0.5 to 1 percent) are used to improve resistance to moisture but the strength properties of the finished board decrease with increasing amounts of size.

Particle board was first made, both in the experimental stage and in commercial production, in flat presses, and the vast majority of plants operating today employ multi-platen presses. In the flat platen pressing process the glued particles are layered parallel to the faces of the board. The chips are bonded together by pressure perpendicular to the board surface (flat pressing). The particle boards so produced have their greatest strength in the plane of the board.

Intensive research in Western Germany during the period 1947 to 1949 led to the development of the extrusion process, which speedily found commercial application. In the extrusion process the glued particles are forced by a reciprocating piston through a long rectangular heated die, virtually made up of two platens with side stops. Bonding takes place under the influence of pressure and heat and the thickness of the endless, extruded board is controlled by adjusting the dimension of the cross-section of the mouth of the press. In the extrusion process the particles are chiefly arranged perpendicular to the direction of pressure and perpendicular to the surface of the board. The extruded boards have their lowest strength in the direction of the extrusion. In the two other planes perpendicular to the direction of the extrusion the strength is greater.

Today, there are in existence or under construction about 35 plants utilizing the extrusion process in various parts of the world, including 17 in North America. Although extruded board does not possess the same strength characteristics as flat pressed board, it can serve in a number of applications. Nearly all extruded board is presently used as a core material, for utilization after facings have been applied. However, not all the strength properties are equally relevant in various applications, and certain applications in which unveneered extruded board has proved satisfactory have been reported. The importance of extruded board springs from the fact that, for a given output, the capital cost of an extrusion plant is approximately half that of a multi-platen plant. This explains the rapid rise in its popularity, especially for operators anxious to convert their own or local wood residues into core material for use in a subsequent operation, e. g., furniture manufacture.

More recently, a continuous process for the production of flat-pressed particle board has been devised, and five such plants are now in production or under construction. The capacity of the continuous press unit is fairly high, 25 to 33 thousand cubic meters annually, depending on the thickness of the board. The capacity of the unit, and hence the investment required, render the continuous press unsuitable for small captive plants or for localities lacking a sizeable potential market. However, if the running speeds now claimed are realized and maintained in practice, the continuous press is likely to be more widely adopted in those areas where marketing possibilities can ensure that its capacity will be effectively utilized.

Most particle board produced is in the intermediate density range, 0.40 to 0.80 gram per cubic centimeter. The majority of production is of single-layer (homogeneous) board or three-layer board, though two-layer board is not unknown. In three-layer board, higher quality particles are used on the surface, improving strength, stiffness and appearance.

Particle boards are extensively used as core stock for veneer and other overlaid furniture and as panel material. Applications involving more severe service conditions are increasing. Phenolic or melamine resins, having greater resistance to heat and moisture than urea, should be considered if the exposure conditions are severe. Particle board is also used for flooring and for facing concrete forms.

World production of particle board today exceeds one million cubic meters but this figure is well below current world capacity since the industry is undergoing very rapid development.

The following Table gives estimated world particle board production for 1950 to 1956:

Table 1. – Estimated World Output of Particle Board, 1950 to 1956
(in thousands of cubic meters)

Region	1950	1951	1952	1953	1954	1955	1956
Europe	10	40	80	120	270	450	775
North America	10	15	30	80	120	180	240
Oceania							2
Africa				5	15	25	50
Far East				2	5	8	12
Near East							6
Latin America					1	5	16
World	20	55	110	207	411	668	1 101

As already explained, the figures in this and the subsequent Table are based largely on unofficial data. Nevertheless, it is believed that they indicate with reasonable accuracy the orders of magnitude today

involved and the approximate geographical distribution of production.

It will be seen that Europe today accounts for over two thirds of all particle board produced. In no other forest product does Europe enjoy this pre-eminence. The reasons for this are briefly discussed below.

The tremendous growth rate of this new industry is evident, even if allowance is made for the fact that — owing to inadequate statistics — output figures for the earlier years are understated. Moreover, the rapid expansion continues, as may be seen from the following table which presents, by countries and regions, the number of mills and their output in 1956, and expected capacity in 1957/58:

Table 2. – Particle Board: Estimated 1956 Production and 1958 Capacity

Region	Number of mills		Production capacity	
	existing in 1956	under construction	1956	1957/8
			..in thousands of m^3..	
Europe	*114*	*23* plus	*775*	*2077*
Austria	3	2	35	65
Belgium	7	2	140	200
Bulgaria	—	1	—	30
Czechoslovakia	1	several	7	160
Denmark	1	—	12	12
Finland	1	4	10	100
France	12	7	100	300
Germany: West	47	several	270	600
East	6	several	18	100
Hungary	1	—	—	10
Italy	5	—	40	80
Netherlands	9	—	20	40
Norway	—	3	—	40
Poland	2	—	—	20
Romania	—	1	—	35
Spain	1	—	8	15
Sweden	2	2	5	50
Switzerland	9	—	60	80
United Kingdom	7	1	50	80
Yugoslavia	—	—	—	60
North America	*59*	*2*	*240*	*750*
Canada	3	—	45	50
United States	56	2	195	700
U.S.S.R.	—	*several*	—	*80*
Oceania	*1*	*1*	*2*	*25*
Australia	1	—	2	15
New Zealand	—	1	—	10
Africa	*4*	—	*50*	*75*
Northern Rhodesia	1	—	50	75
Union of S. Africa	3	—		
Asia	*9*	*4*	*18*	*66*
Israel	1	1	—	8
Indonesia	—	1	—	8
Japan	7	—	12	25
Taiwan	—	1	—	5
Thailand	—	1	—	8
Turkey	1	—	6	12
Latin America	*7*	*2*	*16*	*64*
Argentina	—	1	—	16
Brazil	2	—	5	8
Chile	—	1	—	5
Colombia	3	—	3	20
Mexico	1	—	5	10
Uruguay	1	—	3	5
World Total	*194*	*32* plus	*1101*	*3137*

The wide margin between 1956 production (1.1 million cubic meters) and expected capacity by the end of 1958 (3.1 million cubic meters) is a clear indication of the rapid expansion which this industry is presently undergoing. Thus in the space of less than a decade the particle board industry will have reached a capacity — around 2 million tons — which exceeds the current production of either insulation board or hard fibreboard.

Current expansion plans suggest that Europe will continue to dominate the pattern of world production, though the United States will displace Western Germany as the world's largest single producer. Practically the whole of European production is concentrated at the present time in the countries of continental western Europe, the shares of Scandinavia and eastern Europe being so far relatively small. In fact, the Federal Republic accounts today for over one third of European production and one quarter of total world output. Belgium, Denmark, East Germany, Italy, the Netherlands, Switzerland, the United Kingdom — all wood deficit countries — together account for 340,000 cubic meters, almost another third of world output.

These figures will be slightly modified when mills now under construction come into operation. Over 30 mills are due for completion by the end of 1958, bringing the world total to over 225.

A comparison of the regional distribution of fibreboard and particle board capacity is of some interest:

Table 3. – Percentage Distribution of Capacity, by Regions

	Fibreboard (1955/6)	Particle board (1957/8)
	..... *percent*	
Europe	*38*	*66*
of which:		
3 northern countries	22	6
Timber deficit countries	12	38
Germany (West and East)	4	22
Other west European timber deficit countries [1]	8	16
Rest of Europe	4	22
North America	*50*	*24*
Rest of World (incl. U.S.S.R.)	*12*	*10*
	100	*100*

[1] Belgium, Denmark, Italy, the Netherlands, Switzerland and the United Kingdom.

Thus the world pattern of this industry is, and seems likely to remain in the near future, quite unlike that of fibreboard and, indeed, quite unlike that of any

other forest product. The main concentration is in Western Europe and, in particular, in the timber deficit countries of that continent.

There are several reasons why the timber deficit countries of Europe have cradled the particle board industry. Less well endowed with forests than most other areas, there has naturally been a greater emphasis than elsewhere on full utilization of the forest crop and of the residues of wood-processing industries. Faced with giant postwar reconstruction needs — for buildings, for furniture etc. — and hampered by sawnwood shortages, necessity mothered invention in this area and brought the new industry into being. As technically advanced countries, there were already in existence modern chemical industries capable of furnishing adequate quantities of necessary binders at reasonable cost. Many of the first mills were small captive plants, making use of wood residues arising in sawmills, plywood mills or furniture factories to manufacture core stock which could replace sawnwood, blockboard and plywood in furniture manufacture. Those mills producing for sale found a ready market for their products, and the number of producing units multiplied rapidly — a trend favored by the fact that the amount of capital required to establish a new plant is much less than for a fibreboard project, while the raw material requirements are much less exacting.

The two main factors in the rapid growth of the particle board industry have thus been:

a) the need to find a substitute for solid wood where that has become scarce or relatively expensive;

b) the will of operators to turn to profitable account residues arising in their forest products operations.

Obviously, these factors are not unrelated.

The 50 or so plants in production or under construction in the United States are mainly concentrated in the Douglas fir region of the Pacific Coast or in the furniture manufacturing centers of the eastern seaboard and the Middle West. The highly developed sawmilling industry of the Pacific Coast gives rise to vast quantities of sawmill residues. While most of the slabs and edgings can find a ready market as pulp chips, the considerable volume of planer shaving are so far not suited for pulping. Thus planer shavings may come to be the most important single raw material for particle board in this area. Generally speaking, the board there produced is for the market, and with labor costs high and heavy freights involved in reaching the principal consuming centers, the tendency is towards large, highly mechanized mills to keep the product competitive.

In the east, operating costs are lower, and with markets nearer, smaller mills can be economic. In any case, many of the mills there operating are captive plants making use of furniture mill waste to produce panel and core stock for use in the parent plant in the manufacture of doors, carcase furniture, etc.

So far in the States there is little recourse to roundwood as raw material; by and large particle board production is undertaken as a means of valorizing mill residues. With adequate supplies of these still available, there is less incentive to utilize forest waste or roundwood, both of which are more expensive.

In Europe, on the other hand, both roundwood and forest waste are being used. The former (frequently species without a high current commercial value) permits the production of superior engineered particles for the outer layers of three-layer board, while the latter, along with the miscellaneous mill residues, is adequate for the center stock.

Both in Europe and North America, there seems to be a distinct tendency towards the employment of engineered, controlled dimension particles, partly on the grounds that this makes it easier to control the quality of the board and determine its properties, and partly because it permits significant economies in the amounts of binder required; as already mentioned, binder is the biggest single cost item, and any savings achieved here can warrant the employment of more costly wood material. It should be observed that views concerning the savings which can be realized are by no means unanimous; it is evident, however, that a decision on the most economic form of wood raw material in any particular instance will have to take this factor into account.

Consumption and trade

No figures are available for international trade in particle board, since the product is too new to have obtained recognition as a distinct commodity in the trade accounts of most countries. Yet some particle board is already traded internationally, mostly between neighboring countries — though there are some instances of long-distance trade; South African particle board, for example, is marketed in western Europe, while several European producers make shipments to markets in other regions. Some expansion of international trade in particle board is to be expected, but it is unlikely that the proportion of world production entering long-distance trade will ever be as high as for hardboard. It is relatively bulky in relation to its value; its raw material requirements are less exacting; and the economies of plant size are less pronounced. Thus the establishment of a relatively small plant to satisfy local requirements presents fewer difficulties, and the product of such a plant is less vulnerable to competition from the high quality production of large-scale mills in established producing centers.

Since international trade is still small, it may be assumed that current production in the main producing countries corresponds fairly closely to consumption. In the following Table *per capita* consumptions of fibreboard and particle board in selected countries are compared.

Table 4. – Per Capita Consumption of Fibreboard and Particle Board in Selected Countries Compared

Country	A *per capita* consumption of fibreboard, 1954/5	B *per capita* consumption of particle board, 1956	A plus B
	..... *in kilograms*		
Sweden	22.1	.4	22.5
Finland	16.8	1.4	18.2
Belgium	3.4	9.6	13.0
Switzerland	4.0	7.4	11.4
United States	9.0	0.7	9.7
Denmark	5.7	1.6	7.3
Netherlands	6.1	1.1	7.2
Austria	3.1	3.1	6.2
Union of South Africa	3.4	2.2	5.6
Western Germany	2.2	3.1	5.3
France	2.0	1.4	3.4
Italy	0.9	0.5	1.4

Note: Only volume figures of particle board production are available. In this Table an average density of 0.6 has been assumed.

For reasons which have been explained, the consumption figures given in column B are only very approximate. Moreover the final column does not correspond to actuality, since columns A and B relate to different years. Nevertheless the Table suggests that particle board consumption does to some extent compensate for differences in fibreboard consumption levels, so that the disparities in consumption levels for all board are somewhat less marked than those for fibreboard alone. This is notably the case for Belgium, Switzerland, Austria and Western Germany. The Table appears to confirm that in several European countries particle board has found markets which otherwise might have been won by fibreboard.

In many applications fibreboard and particle board can be used alternatively at the present time. However, in spite of the considerable area of competition, both industries are still expanding rapidly. During the last four years, in which output of particle board has rocketed, production of fibreboard, especially of compressed fibreboard, has also risen considerably. In the short space of ten years, output of all board has more than trebled, rising from 1¼ million tons in 1946 to over 4 million tons in 1956.

Prospects

Information assembled in the course of the International Board Consultation and presented in Table 2 shows that the expansion currently taking place in particle board capacity is even more spectacular than had generally been believed. Not unnaturally, counsels of caution are becoming more frequent. While in most countries marketing possibilities appear excellent, in others there may be a danger in the near future that supplies will at least temporarily outrun effective demand. This danger seems most imminent in the United States and in certain west European countries. While the current growth rate may not be sustained, continued expansion seems certain, since this new industry has exploited few of its potential outlets.

The longer term future for particle board depends primarily on two factors:

a) its price trend in relation to alternative materials;

b) the success achieved in the search for new applications.

Hitherto particle board has competed mainly with plywood and blockboard, and to a lesser extent with solid timber. Any reduction in the price of particle board relative to the prices of other materials could extend the utilization of particle board.

As production increases in the coming years, and as ready outlets for particle board become more nearly saturated, the pressure of competition may well bring about a reduction in the price of particle board relative to other materials. Since this is an emergent industry still undergoing technical evolution, existing installations vary greatly in the raw materials they use, in equipment and processing, in the nature of the product, and in size of plant.

In consequence, there are very wide differences in production costs from plant to plant, and selling prices are by no means standardized. While profit rates vary, with many modern plants reaping exceptionally high profits, many of the smaller and older mills producing for the market are already experiencing difficulties and a number have gone out of existence. As competition becomes more intense, the weaker mills will be subject to increasing pressure; at the same time a fall in the relative price of particle board, which would appear to be within the reach of modern, well-equipped mills, would strengthen the campaign for new outlets.

Nevertheless, while the industry must inevitably encounter certain growing pains in the course of the next few years, the long-term future of this new and vigorous forest products industry seems assured.

The Work of FAO

Asia-Pacific Forestry Commission

Indonesia was host to the Fourth Session of FAO's Asia-Pacific Forestry Commission held at Bandung from 8 to 21 June 1957. Sixty-three representatives from the following countries participated: Australia, Burma, France, India, Indonesia, Japan, Laos, Malaya, the Netherlands, the Philippines, Thailand, the United Kingdom, Hong Kong, North Borneo, Sarawak, Singapore, and the United States. Observers were also present from the U.S.S.R. and from the International Organization for Standardization (ISO), the Regional Housing Center, UN Economic Commission for Asia and the Far East (ECAFE), and Indonesia State Planning Bureau and local societies.

Mr. Marcel Leloup, Director of the Forestry Division, represented the Director-General of FAO, and Mr. C. S. Purkayastha, FAO's Regional Forestry Officer, acted as Secretary.

The Minister for Agriculture of Indonesia, Dr. Sadjarwe, opened the session and received the warm thanks of delegates for the excellent arrangements made for the meetings and for the generous hospitality displayed by the host country.

The Commission elected Mr. Soesilo H. Prakoso (Indonesia) as its new Chairman. Mr. Thiem Komkris (Thailand) was elected First Vice-Chairman and Mr. Tiburcio Serevo (Philippines) Second Vice-Chairman. Mr. F. G. Browne (Sarawak, U.K.) was chosen Rapporteur for the Session.

Progress in the region

The feature of the business meetings was a review of the progress made in forestry in member countries of the region since the last session in Tokyo just over two years ago. In introducing the discussions, Mr. Leloup expressed appreciation of the rapid progress that undeniably had been made. He had some doubt, however, whether this progress was sufficiently coordinated or integrated either between the different fields of forestry or with the other sectors of the economy with which forestry activities must be dovetailed; and whether sufficient consideration had been given to the fact that rapid industrialization of a country, and perhaps profound changes in agricultural policy, must lead to changes in the pattern of land-use.

With only one exception detailed reports had been submitted to the present session by all member countries, and the main trends revealed by these reports were highlighted by delegates. In several countries, forestry and forest industry development projects have found an important place in the over-all national economic development plan, although their implementation is sometimes hampered by limitation of funds and shortage of trained technical personnel. A number of countries reported progress in land classification and the setting up of national committees, composed of various interests, for the purpose of land use planning. They also reported progress made in the inventory of their forest resources.

Some countries are pursuing a policy of increasing forest areas by purchases of private land for forestry purposes, and of encouraging farm forestry, sometimes through the establishment of farm forestry associations. The establishment of community forests is receiving increasing attention, and in many instances conditions appear to be favorable for the creation of village forests. Firm guidance from the forest services is, however, essential to ensure the success of village activities connected with the management of such forests.

Increasing interest and activity in the field of soil conservation including fixation of sand dunes by planting, was noted. In connection with the problem of shifting cultivation, measures were reported which have been taken to encourage nomadic people to settle, such as the introduction of perennial crops and, in some cases, assistance to cultivators by the provision of houses and cattle, and steps to protect forests from fire and encroachment. With the rising pressure of population and costs of living, the risk of breaches of forest law grows. Increased employment in forestry activities under development schemes help to minimize these breaches.

Forest improvement work such as regeneration and reforestation, and silvicultural and management work generally, are receiving increasing attention in many countries. Large areas are being brought under working plans, and forest plantations extended on a large scale. Experimental introduction of exotics as well as the establishment of fuelwood plantations and windbreaks were mentioned by some delegates.

Where forest grazing poses serious problems, and in some countries it was reported as being of major concern, efforts are being made to enforce regulations and restrictions including deferred or rotational grazing. Closure of overgrazed areas in arid zones have resulted in markedly increased growth. Introduction of fodder species in afforestation areas and improvement of the grass cover are other measures employed, as well as the promotion of stall feeding. The need for research and experimentation in forest range management is being increasingly realized.

With few exceptions, steady progress was reported in mechanization of logging and transport operations, and the construction of more forest roads. Most countries still find that a combination of animal and power traction is most suitable. Owing to the construction of dams, river floating of timber is becoming less important as a means of extraction and transportation.

Practically all countries reported either expansion of forest industries or an increase in their number. The need was clear for rationalization and modernization of the sawmilling industry in the region. Some progress is evident in the utilization of lesser known

hardwood or secondary species, which has largely resulted from research in impregnation and seasoning. Great interest was shown in many reports in the testing of secondary hardwoods both for pulping and for the manufacture of plywood and furniture, as well as for construction purposes. Impregnation of secondary timbers for sleepers is being carried out on a commercial or experimental scale in several countries. The various lines of research being carried out should greatly widen the use of secondary timbers, particularly if the results obtained are given adequate publicity in trade channels.

The increasing use of gas, electricity, oil and coal, and improvements in cooking and heating devices, are relieving the demand on forests for fuel in some countries of the region. However, in countries with large and dense population such as India, Pakistan, Ceylon and Java (Indonesia), fuel shortage is acute. Fuel plantations already established are a step in remedying the situation, but much more remains to be done as a matter of high priority.

Improvements were reported in some cases in the wages and living conditions of forest and wood industry workers, but in many countries there is a scarcity of forest labor, and particularly of skilled labor. Various incentive schemes are in operation for the purpose of stabilization of the labor force and attracting newcomers to forestry work.

Technical discussions

The agenda of the Commission had a heavy number of technical items to be dealt with. For some of these special *ad hoc* committees were appointed as follows:

Education in forestry:	*Chairman*: J.C.K. Marshall (Malaya)
Silviculture and management research:	*Chairman*: G.G. Takle (India) *Rapporteur*: J. Wyatt Smith (Malaya)
Forest products research:	*Chairman*: Nizar Kamil (Indonesia) *Rapporteur*: H. J. Burgess (Malaya)
World Forest Inventory 1958 and forestry statistics:	*Chairman*: H. R. Gray (Australia) *Rapporteur*: H. Tromp (FAO)
Nomenclature, grading and standardization of hardwood logs and sawn hardwood:	*Chairman*: C. O. Flemmich (Singapore) *Rapporteur:* E. Andresen (Thailand)

The reports of these committees were endorsed by the Commission and appear in the final report of the session. It was agreed that the recommended grading rules for hardwood logs and sawn hardwoods should be published by FAO.

As regards higher forestry education, eight countries now provide full professional courses in forestry, while the others avail themselves of training facilities abroad. Intermediate training is available in eleven countries, though the levels of training are not entirely uniform. Training of forest guards or foremen is organized as in-service training or in the way of regular courses. Training centers or extension services are in a few cases used to improve the forestry knowledge of forest owners.

Increased activity in the field of propaganda and education of the public in the importance of the forests and their conservation was reported from practically all countries in the region. Tree festivals (Arbor Days), establishment of school forests; propaganda by means of films, pamphlets, posters, radio broadcasts, and prizes and awards for planting were indicated as the means employed to that end. The introduction of forestry subjects in the regular training of administrative officers, and in community projects and extension courses as reported by one country, is noteworthy.

Work of FAO in the region

Finally, before proceeding on various tours arranged by the Indonesian authorities, the delegates reviewed current FAO activities in the region and advised the Director-General as to the desirable future orientation of FAO's work as it affected the Asia-Pacific area.

An interesting debate on watershed management and shifting cultivation led the Commission to urge that a training center on research methods and techniques in watershed management should be established by FAO in one of the tropical countries of the region. Member Governments should take steps to include watershed management in curricula of forestry courses in schools, and should consider observing a national soil and water conservation week, as is done in Ceylon, to promote better public understanding of these problems.

The Commission recommended that an *ad hoc* Working Party on Forest Working Techniques and Training of Forest Workers be set up, comprising specialists familiar with both modern technical organization of forest work and specific regional problems. This Working Party should act as a preparatory body to a permanent working party or committee, to be set up later, similar but not necessarily identical with the joint FAO/ECE Committee.

The Secretariat reported on the progress made with the study on timber trends and prospects in the region, recommended by the previous session of the Commission to be undertaken by FAO in collaboration with ECAFE. After approval of the study by ECAFE, an outline for country reports had been drawn up and co-ordinators appointed in many countries. When the country reports have been submitted by all the co-ordinators, ECAFE and FAO will be able to proceed with their critical analysis and the elaboration of the whole study. The Commission fully appreciated the many difficulties with which Member Governments had to cope in collecting the necessary data but expressed satisfaction with the statements made by a number of delegations that the collection of this information had made their governments aware of the serious scarcity of statistical data essential for the formulation of sound forest policies,

and that in some cases steps had already been taken to remedy the situation.

The Commission welcomed a proposal to organize in 1959 a Far Eastern meeting of economic and technical experts on the pulp and paper industry in collaboration with ECAFE, similar to a meeting held in 1954 in Latin America. The pros and cons of exploiting natural tropical forests or establishing plantations of quick-growing species in this region should be considered along with other technical and economic problems.

Teak Subcommission

The first meeting of the Teak Subcommission of FAO's Asia-Pacific Forestry Commission was in Bangkok in 1955. It met for the second time at Bandung, Indonesia, during the period 4-10 June 1957. Thirty-two representatives participated from Australia, Burma, France, India, Indonesia, Laos, Thailand, the United Kingdom and the United States of America.

Mr. G. G. Takle, Inspector-General of Forests, India, and *ex officio* Chairman of the Subcommission, expressing thanks to the Government of Indonesia and the Indonesian Forest Department on behalf of the delegates, said that India owed a great deal to the management and silviculture of teak in Java which had greatly influenced in early years techniques in India and elsewhere. There was provision for very large-scale plantations of this species during India's second Five-Year Plan so as to increase the proportion of teak which at present is confined to only 8 percent of the total forests.

Bibliography

One of the basic functions of the Subcommission is the compilation and publication of a bibliography on teak. A large body of literature in several languages already exists, recording the results of research, observation, and studies on the silviculture, management and utilization of teak. The progress made so far with a bibliography has been rather slow, and the Subcommission asked the countries concerned to expedite the work and submit the required information to the Secretariat as early as possible.

Growing of teak

The Subcommission received reports on teak grown under exotic conditions from some 30 territories or states in Africa, the Asia-Pacific region and Central America. The information submitted varied too much in presentation to permit a comparative analysis of the results, but it was obvious that:

(*a*) There is a widespread interest in the introduction of this valuable species under appropriate climatic conditions in different parts of the world.

(*b*) Reports of success and failure are divided. The comparatively high proportion of failures points to the need for the compilation of a manual on the silviculture of teak for the use of countries desiring to introduce teak as an exotic.

(*c*) Where the introduction has been a success, there are plans for large-scale propagation of this species though scarcity of suitable land is in some cases a limiting factor.

(*d*) Damage from insects and other injurious organisms seems for the time being to be less under exotic conditions than in the natural teak-growing areas.

(*e*) Even where growth is poor, teak can still usefully meet local needs for poles, posts and fuelwood.

Considerable progress has been made in the cultivation of teak in some African territories, and extensive plantations have been established because of the good results of pioneer trails. A noteworthy feature is the plentiful natural regeneration spreading from the early plantations established prior to the first world war. Generally results have been satisfactory in those areas where there is a distinct dry season and soil is suitable, but even under more adverse conditions teak can still be profitably grown.

Discussions revealed disagreement among different experts on the effect of teak on fundamental soil characteristics. There was danger in attempting to judge the suitability of a particular locality for the growth of teak merely on the basis of early growth. Many cases have occurred where in the initial stages teak has grown quite well on soils which were later found to be unsuitable to sustain satisfactory growth. The Subcommission thought that, from the evidence so far to hand, it was not yet possible to prove or disprove soil deterioration due to teak. It noted with interest the measures being taken by the Indonesian Forest Service to prevent soil deterioration, mainly control of fire and grazing, keeping the soil under the teak forest covered with natural undergrowth, planting of *Leucaena glauca* along contours, terracing in hilly country, and construction of small wooden dams in gullies. It was stressed that close co-operation between the Forest Service and the Agricultural and Animal Husbandry Services is essential to achieve the desired objectives.

The exchange of views fully confirmed the desirability of further research on ecological and site factors necessary for the successful growth of teak.

Regeneration

Distinction between the various races or strains of teak, whose existence is accounted for by the fact that teak occurs naturally over a large area and therefore under varying climatic, edaphic and biotic conditions, is made either on the basis of differences in mor-

phological characters, physiological behavior, or physical properties of the timber. Experiments on teak races from various origins have been carried out over many years in India and Indonesia, and the Subcommission recommends that this work be extended on similar lines in other countries. To ensure that valid comparisons of results can be made, an appropriate experimental design for the carrying out of this work must be drawn up.

The Subcommission noted with interest that seed-orchards are being established in Indonesia, and that research has started on the vegetative propagation of teak with a view to creating teak clones to be planted in those seed-orchards.

Utilization

The Subcommission went on to discuss management systems, tending and thinning, improvement fellings, injuries and protection, and the inventorying of teak forests. Interesting discussions took place on the activities of the working party on utilization since its establishment by the Subcommission at its first session, as well as on progress made in member countries in the period under review. The Australian Commonwealth Scientific and Industrial Organization (CSIRO) was invited to draw up a program of timber testing for all the interested countries in consultation with the Forest Research Institute, Dehra Dun, India, where most of the testing of teak has been carried out in the past.

Output of teak

Production of teak reported to the Subcommission for the year 1956 was as follows:

Country	Roundwood			Sawn timber
	Logs	Poles	Fuel	
	.. *in thousands of cubic meters* ..			
Burma	...	...	...	59.9
India	206	195	69	55.7
Indonesia	575	...	875	10
Thailand	...	15	...	285[a]

[a] Roundwood equivalent of sawn timber
... Not available.

In Burma, the sustained yield capacity of teak forests is estimated to be 250,000 tons of roundwood annually and the aim is to reach this figure. Owing to the ever-increasing demand for teak wood in Indonesia, and the limited scope for expansion of teak forests due to population pressure, increased production can only be brought about by reduction of waste and improved silviculture. Recent inventories carried out in the three northern provinces in Thailand have revealed that there is a serious deficit in older age classes, and the middle-age classes are also greatly depleted. The output of teak will be greatly reduced in the near future and this state of affairs may continue for a number of years.

Trade

Reported exports for the year 1956 were as follows:

Country	Roundwood	Sawnwood
	..... *in thousands of cubic meters*	
Burma	7.6	72.9
Indonesia	8.6	1.2
Thailand	12.4	76.5
Laos	0.6	—
TOTAL	29.2	150.6

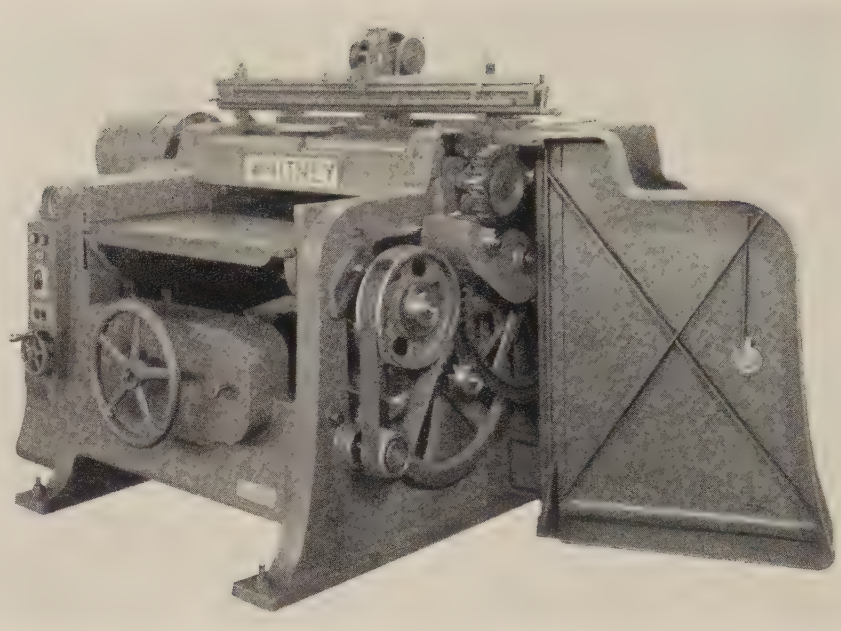
The shortage of shipping facilities and high freight rates charged by shipping firms are serious obstacles to the expansion of trade.

Prices for teak of all categories have risen in all producing countries over the last few years although the increase is not appreciable in Indonesia. This upward trend of prices has made possible the exploitation of teak stands that have so far been uneconomical to work. On the other hand, there is danger of substantial substitution for teak if this upward price trend continues for any length of time. In order to stabilize price at an economic level, Burma is attempting reduction in production cost by improved extraction methods, including mechanization. Thailand is trying modified sale methods by making teak logs available to sawmillers at a controlled price as opposed to competitive price through auction sales.

During the session, the Subcommission was able to record that full agreement had been arrived at on recommended grading rules for teak squares. As regards grading teak logs, progress was also made and agreement arrived at between the representatives of Thailand and of Burma. The Indonesian delegation could not agree to the draft rules, since a different system of grading is traditional in that country. As any further postponement of this question was not likely to yield any change in this attitude, the Subcommission decided that the recommended grading rules for logs as now established by its working party should be published for general information.

There was a great deal of common ground so far as the grading rules for conversion timber were concerned. It was, however, felt that further trials in inspection of conversion timber based on the present draft rules might help to clarify several points still at issue and lead to an agreed set of rules. The Subcommission hoped that by the next session agreement would have been reached.

Equipment Section

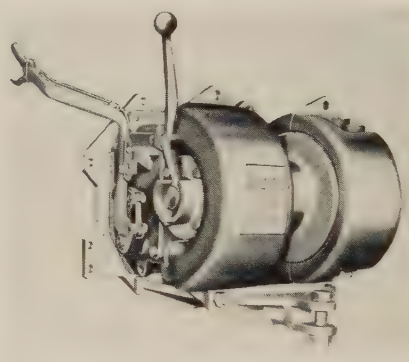


WHITNEY S-290 SINGLE SURFACER. — Particularly adapted for surfacing wide panels, solid or particle board cores. *Specifications*: 36, 38, 40, 42, and 44 in. (91, 97, 102, 107, 112 cm.) wide. Planes stock 1/16 to 8 in. (1.6 mm. to 20 cm.) thick; single pieces 14 in. (36 cm.) long, not butted, or 3 in. (7.6 cm.) long when butted. Feed works gear driven. Whitney S-290 Single Planer furnished with built-in variable speed feed unit, driven by single feed motor. Ranges of feed: 25-75 ft. (7.6-22.9 m.) per min. or 35-105 ft. (10.7-32 m.) per min. Hp. required 25.

Baxter D. Whitney and Son. Inc. Winchendon, Massachusetts, U.S.A.

HYSTER KARRY CRANE MODEL KE. — *Specifications*: Capacity: 6,000 lb. (2,722 kg.), single part line, 10,000 lb. (4,536 kg.), two part line. 4-cylinder industrial type engine, 49 hp at 2,400 governed rpm, liquid-cooled. 7:00 × 20 10 ply dual drive tires. Travel speeds: fwd. or rev. from 3.5 to 13.1 m.p.h. (5.6 to 21 km.p.h.); line speeds: lift, 75 to 108 ft. (23 to 33 m.) per min., lower, 165-240 ft. (50 to 73 m.) per min. Boom lengths: (max. hook reach) 9, 10 and 12 ft. (2.7, 3 and 3.6 m.).

Hyster Company, Portland 8, Oregon, U.S.A.

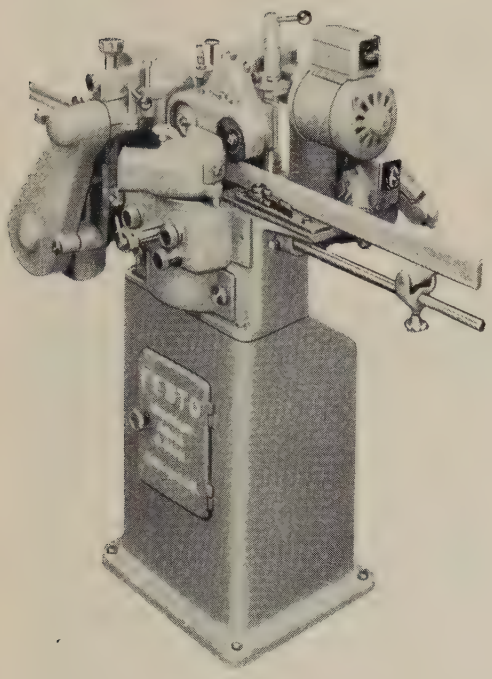


CARCO C3 WINCH. — Compact unit designed to equip small tractor with extra pulling power for wide range of jobs. Converting tractor hp. to winch pulling power, the C3 winch produces line pull up to 10,000 lb. (4,536 kg.). With winch clutch disengaged Model C3 drum rolls free on anti-friction bearings permitting one man operation. All parts standard and interchangeable. Functional design with fewer parts permits servicing without removing winch from tractor.

Pacific Car and Foundry Company, Renton, Washington, U.S.A.

3,000-WATT GASOLINE ENGINE GENERATOR MODEL 41. — Developed to operate electric drills, saws, floodlights and other electric tools. Can be used for emergency stand-by power for light heating plants, water pumps and refrigerators. Unit easily moved to any location to operate electric hedge clippers, power tools and other electric equipment.

Homelite, Port Chester, N.Y., U.S.A.



High-speed Molder Type DS. — For molding profile bars of all kinds. Automatic power-feed and hoods give complete protection against accidents. Short stock up to min. length of 6 in. (15 cm.) molded without danger. Various moldings can be treated on all sides. Where dressed lumber used, two sides can be surfaced or molded on stock up to 3 in. (7.6 cm.) wide. Can also be used as shaper with automatic feed, by removing one spindle and mounting extension table.

Festo Maschinenfabrik, G. Stoll, Esslingen a. N., Germany.

Bucyrus Self-powered H3 Hydrocrane. — *Specifications*: Overall length (standard boom in travel position) 24 ft. 6 in. (7.5 m.); overall height 10 ft. 6 in. (3.2 m.); overall width (outriggers contracted) 7 ft. 11 in. (2.4 m.), (outriggers extended) 11 ft. 8 ½ in. (3.57 m.); boom length (standard) telescopes 18 to 26 ft. (5.5 to 7.9 m.); boom length (high lift with 12 ft. [3.7 m.] insert) telescopes 30 to 38 ft. (9.1 to 11.6 m.); weight 10,500 lb. (4,763 kg.), (with truck) 15,700 lb. (7,121 kg.); road speed (max.) 50 m.p.h. (80 km. p.h.). Pulls (single line): standard hoist rams 5,000 lb. (2,268 kg.); special hoist rams 6,000 lb. (2,722 kg.).

Bucyrus-Erie Company, South Milwaukee, Wisconsin, U.S.A.

Watkins Mechanical Slab and Edging Debarker. — Designed to debark sawmill waste. High-speed rotating cylinders with multiple rows of specially designed chains, attached to steel plates. Material fed lengthwise under revolving cylinder by means of a series of power-driven feed rolls; rate of feed controlled by foot lever. Max. feed: 120 lineal ft. (36.6 m.) per min. Max. size slab 7 in. (18 cm.) thick, 14 in. (36 cm.) wide. Two models available: Model L, 2 debarking cylinders, one for slabs and smaller one for edging strips. 3 electric motors: 15, 5, and 3 hp; capacity 2 to 3 cords (4.4 to 6.5 m³) per hr. Model S, smaller, with one cylinder only. Power required 15 hp; capacity 1 to 1 ½ cords (2.2 to 3.3 m³) per hr.

Sumter Manufacturing Company, York, Alabama, U.S.A.

Beckman Pocket PH Meter. — Used for measurements in plants or laboratories, powered by 6 easily replaceable batteries of type used in flashlights. 400 hours operation from a set of batteries.

Beckman Scientific Instruments Division, 2,500 Fullerton Road, Fullerton, California, U.S.A.

Caterpillar Traxcavator with Libu Bucket. — Bucket fixed to bucket arms of tractor on center shaft, can be dumped hydraulically to either side. *Specifications*: Bucket width 104 $^1/_3$ in. (2.65 m.); dumping angle (to right or left) 45°; dumping clearance 124 in. (3.15 m.); max. height with side dumper bucket 216 ½ in. (5.5 m.). Traxcavator: 100 hp. diesel; overall dimensions: length 19 ft. 10 in. (6 m.); width 8 ft. 8 in. (2.6 m.); height 7 ft. (2.2 m.).

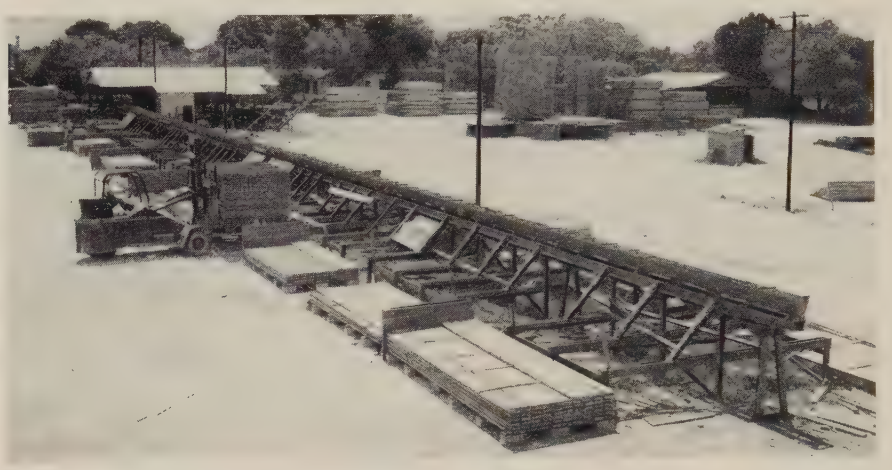
Nilsons Maskin AB, Sundbyberg, Sweden.

Firewood Splitting Machine. — Type "Y" Machine fitted with automatic feed and discharge conveyor. Recommended only where timber is of regular quality and cross section enabling it to be packed in conveyor trough without voids.

M. Glover & Co., Ltd., Hercules Engineering Works, Leeds England.

Wheland Automatic Lumber Sorter. — Designed to reduce heavy labor costs of sorting lumber and to increase operation efficiency. Constructed of heavy steel plates, angles, channels and bars fabricated into rigid members. Breaks down regular sizes of lumber in individual separations for width, length, thickness and grade. Lumber from 4 to 12 in. (10 to 30 cm.) wide, 4 to 20 ft. (1.2 to 6.1 m.) long, 1 to 3 in. (2.5 to 7.6 cm.) thick and for any number of grades desired. Max. speed 286 lineal ft. (87 m.) per min. Special sorters for non-standard sizes can be manufactured.

The Wheland Company, Chattanooga, Tennessee, U.S.A.

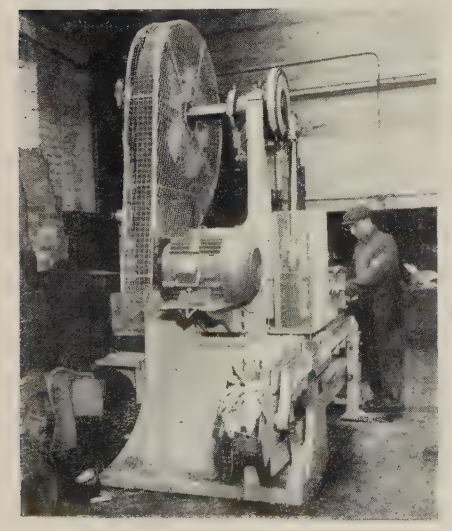


Improved Tusker Dumper. — Main feature: low center of gravity reduces risk of overturning on bad ground. *Specifications*: 1 ½ cu. yds (1.15 cu. m.) capacity. Diesel engine 12 hp at 1,650 rpm; speeds: 1st gear 4 - 5 m.p.h. (6.4 - 8 km. p.h.); 2nd, 7 - 8 m.p.h. (11.3 - 12.9 km. p.h.);top, 12 m.p.h. (19.3 km.p.h.); rev. 3 m.p.h. (4.8 km. p.h.); turning radius 9 ft. (2.7 m.); wheel front tires 7.50 × 20.

Thwaites Engineering Co. Ltd., Cubbington, Leamington Spa, England.

Bouffard Truck-mounted Log Loaders. — Power take-off from truck engine. 2 levers outside of truck cab control complete operation: one for operating control, the other throttle control. Can be operated from either side of truck. Lifting arm may be transferred to either side. *Specifications*: Max. pull 6,000 lb. (2,722 kg.); drum speed 150 ft. (45.7 m.) per min. at 1,800 rpm truck engine speed. Capacity 100 ft. (30.5 m.) of ½ in. (12.7 mm.) cable.

The Universal Log Loaders Ltd., Eastview, Ontario, Canada.



News of the World

Afghanistan

• Writing of visits to the Eastern Province, the FAO forestry officer in Afghanistan indicates that the natural forest has already been pushed back to the steepest slopes and rather inaccessible areas. Full-scale logging on these slopes would be disastrous as erosion would rapidly take place leaving only bare rocks incapable of reproducing any forest crop. The granite soils are in this respect a greater problem than the gneissic soils.

The gneissic soils are nevertheless subject to severe erosion as was seen in the Waziri Valley, where the *Cedrus* and pine forest had been completely logged. In this area there is a useful amount of natural regeneration which if protected from any further cutting and grazing will lead to re-establishment of the forest cover.

There are some magnificent coniferous forest stands on the unstable granite formations. These forests should be regarded as protection forests and never be opened up for logging. From time to time for local village uses such as water races for irrigation and local building needs, damaged or overmature trees could be selected and removed without exposing the soil to erosion.

Climatically the Jalalabad area offers excellent prospects for the establishment of fast-growing plantations. At present it is considered that poplars, some of the Eucalypts, one or two conifers and *Cedrela toona* are likely to give excellent results. With these species a good range of wood for all uses — from fuel wood to high grade cabinet wood, could be obtained.

Lying south of the Safed Koh, the Southern Province presents a completely different forestry picture. The soils derived from sedimentary rocks are much more stable but the Himalayan cedars apparently growing in their southern limit do not form the same magnificent forest stand as was seen in Eastern Province on the granite and gneiss soils. However, since these forests are on the more stable soils, they will be better able with protection and management, to provide cedar wood for the market.

It is a rare experience when making a forestry survey to visit areas where the answers to some of the problems are already demonstrated, but in Southern Province such examples were seen; range grasses were seen in abundance in an area closed to grazing and regeneration of *Pinus gerardiana* and *Cedrus deodar* were seen in a partially protected forest area.

In mixed stands of *Cedrus* and *Pinus gerardiana* the objective will be to foster the growth of the Cedar to produce logs of this very good species. Both the pine and the juniper which occur in this type are of importance to this objective since they will provide the necessary shelter which the young cedar plants require in order to establish themselves. The pine will in addition provide wood and nuts but should always be regarded as secondary to the cedar.

At Khohi Surati an area was visited which had been completely logged some years back of all cedar and pine logs. This logging operation was followed by good regeneration of both species. As the regeneration has grown up it has been cut for fuel and some small poles but not permitted to develop into logs. Fortunately both species have coppiced and generally around each stump are now found 4 or 5 stems each 10 to 20 feet (3 to 6 meters) in height. The pine coppice is setting seed and quite a few seedling pine were found. There was very little evidence that the coppice stumps of the cedars had done likewise.

On the higher slopes of the sheltered gullies some cedars 40 to 50 feet (12 to 15 meters) in height remain and should provide some seed. It is considered that these trees were probably very small at the time of the main logging operation or grew up immediately after, and have since escaped the ax. The people of the village stated that they wished to allow the trees to grow to economic size and it did seem that very little cutting for fuel had been done for at least a couple of years, although there was evidence of grazing. If the whole area had escaped further cutting in the same way, there would have existed in this area a really good young forest.

Belgium

• A law on the inspection of seeds and planting stock for forests was promulgated in 1956. Its purpose was to establish, side by side with the free market, one under State control, in which producers who wished to do so might participate.

Inspection of seed and planting stock for forests is carried out in three stages; selection of seed-tree stands, supervisions over harvesting, and inspection during seed preparation; these are performed by State forestry officers, by the Water and Forest Research Station and by the National Horticultural and Agricultural Products Marketing Office (ONDAH). The purpose is to give producer identification certificates stating species, by type or variety, provenance and to assure their healthy condition.

The Water and Forests Research Station selects seed-tree stands and publishes regularly a list of such stands. It also fixes and publishes seed production standards (by unit weight of cones) and standards for planting stock (by unit weight of seed). There is also selection of woodlands under forestry management by the State Forest Service and of privately-owned woodlands, as well as of stands belonging to private bodies, the owners of which have applied to the Ministry of Agriculture for this purpose.

As regards supervision over harvesting in the case of stands managed by government services, the head of the competent Water and Forests District Office and ONDAH are warned eight days before the date of harvest. The harvester then carries out the harvesting of the seed under the surveillance of the Water and Forests Administration. Afterwards a check is carried out by the ONDAH expert who issues, for the sample quantities of the accepted seed, a dated "certificate of provenance" in four copies countersigned by the harvester and stating the species, the breed, variety, and complete catalogue description of the seed-tree stand and the quantity of fruits, cones or seeds harvested.

In the case of a non-state-managed woodland, an owner who has one or more stands that have been approved for seed production, undertakes to be present at the supervised harvesting of the seed. The expert sent by ONDAH at the harvester's request for such supervision, supervises the harvest and, if the seed is acceptable, draws up a certificate of provenance.

Seed preparation is supervised by the ONDAH expert, who sends out checks on the certificates of provenance, supervises the preparation, takes whatever samples he deems nec-

essary and, if the merchandise is acceptable, issues several small denominational stamps, according to the quantity of seed obtained. The quantities of acceptable seed may not surpass the figures set by the Water and Forests Research Station. For each delivery of selected seed, the preparer draws a statement on forms issued by ONDAH, indicating deliveries and stating: the species, or variety, the full catalogue description of the seed-tree stand, the quantities delivered, the date of harvesting and of inspection.

There are two steps involved in the inspection of planting stock in the nursery: the inspection of standing stock and of stock for sale. Planting stock may be refused or accepted provisionally after its initial growth period. It can either be refused or definitely accepted after the second growth stage. After each of these stages a second expert opinion may be obtained from ONDAH, at the expense of the claimant, unless the finding on the initial inspection are changed in his favor.

Only plots of standing stock that have been seeded with select seed may obtain inspection. The number of plants accepted may not exceed that set by the Water and Forests Research Station. Inspection of standing stock calls for one or more visits to the plots. In order to be accepted, the plots have to meet the technical standards set by ONDAH.

Only plants from approved stock may be inspected for the purposes of sale. When a request for inspection is submitted to ONDAH sufficiently ahead of time, an expert is sent out to make an inspection of planting stock for sale, which includes a general examination of the plots and a count of the number of plants for sale.

Canada

• A Technical Note issued by the Forestry Branch of the Department of Northern Affairs and National Resources describes a survey of the tolerant hardwood stands in the provinces of Ontario and Quebec, Canada, which was oriented to a determination of the ecological characteristics of the hard woods in various forest districts as basis for recommending silvicultural management. The principal species are sugar maple, yellow birch, beech, red maple and basswood.

In all but the most northern areas, sugar maple is the dominant species and is so aggressive that it can increase its numbers at the expense of the other species. Most of the trees and reproduction are defective, and there are few areas where it is capable of developing into trees suitable for sawlogs and veneer. If high quality maple stands are to be obtained, cultural treatment to release young growth from overhead shade and to protect young saplings from injuries must be undertaken.

Yellow birch is widely distributed but to restock cut-over areas it requires suitable seed beds and freedom from competition with advance growth of other species, especially sugar maple. To establish the species in quantity it will be necessary to use a system of partial cutting, prepare seed beds and destroy advance growth of sugar maple and, if overdense birch stands are obtained, the best stands will have to be thinned.

Beech is sensitive to extreme cold and is mostly confined to upper slopes and ridges. It is very defective and, with present utilization limits, its elimination should be sought wherever possible. Basswood is important in the southern areas but is never the dominant tree. It reproduces by stump sprouts, but to obtain seedling reproduction probably heavy cutting will be required to hasten the decomposition of the seed coats.

Other species in the tolerant hardwood forests are of more limited occurrence and have limiting silvicultural characteristics so that, if their perpetuation or increase is sought, rather special silvicultural measures will be required.

Ceylon

• A report to the Asia-Pacific Commission states that the aerial photographic aircraft which operated in Ceylon under the Colombo Plan Aid from Canada, has completed the 1 : 40,000 general purposes photography of the Island and the larger scale aerial surveys, to scale of 1 : 15,000, of the inaccessible forests in the wet zone in Southern Province and montane grasslands in the hill country: 2-inch-to-the-mile scale controlled mosaics are being prepared.

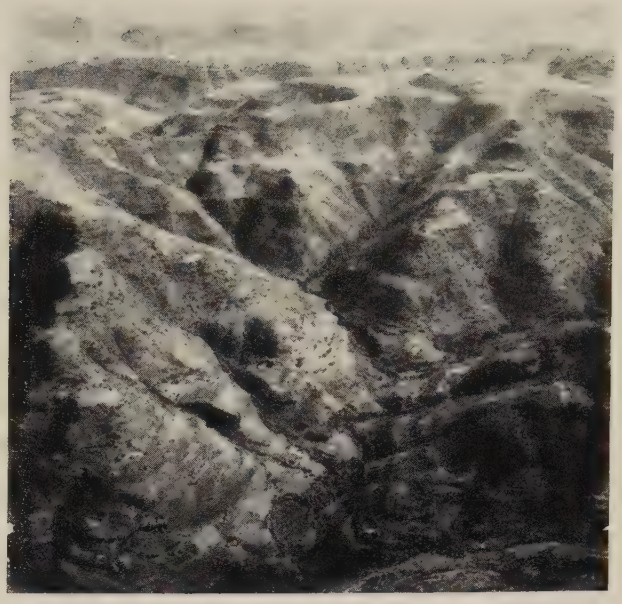
Two officers of the Forest Department, a junior assistant conservator of forests and a senior forester, underwent a course of lectures by the Canadian specialists on photogrammetry and other allied subjects in Colombo and also attended the field camp at Tellulla for investigation of the resources survey of the Kirindi Oya Basin.

Interpretation of aerial photographs has now been carried out and arrangements have been made for carrying out ground sampling and preparation of a forest inventory for the Sinharaja Forest Block.

Aerial photography has considerably helped in the recognition of the different gross forest types: high forest, low and scrub jungle, grassland and fernlands within both the major wet and dry evergreen forest types, which information cannot be ascertained from the available topographic

CUBA. *The Lion's Club of Havana has appointed a Committee of "Friends of the Tree" to promote, throughout the country, the planting of native forest trees by pupils of public and private schools. A prize will be awarded every year to the school which has given the best care to the plantations. Chairman of the Committee is Ing. Servando Oviés, shown in this photograph with the President of the Cuban Botanic Association and Father Teste, creator of the Cuban "Boys Town", at a ceremony initiating a school woodland.*

EGYPT: *There is a considerable movement of animals for slaughter from Syria on the east and from Libya on the west into Egypt. There is scant forage for the animals along the trekking routes as is shown by this photograph, taken by the Regional Forestry Officer for the Near East. He advocates the creation of protected groves of fodder trees at stop-over points.*



ETHIOPIA: *The valley near Debre Markos over which a group of technical experts recently made a reconnaissance flight. The result of water erosion over millions of years, it consists of a number of plateaus intersected by 'innumerable gorges and chasms with steep slopes and in places perpendicular walls, in which the silvery thread of the river and its tributaries flow'.*

maps of the island. It also assists in the determination of the soil types, depth of soil and other soil phases. It depicts land subjected to erosion, other forms of misuse of land and shows the extent of afforestation possible for reclamation and protection.

Ethiopia

• A group of technical advisers, including FAO experts, has carried out a series of reconnaissance flights in Ethiopia to permit in the shortest possible time a preliminary evaluation of land use problems over extensive areas, which it is otherwise impossible to obtain except at great expense of time and money. It is expected that further flights and more detailed surveys of selected districts will be carried out, combined with aerial photography.

A report on one flight includes the following:

"From Gondar we flew south across the eastern half of Lake Tana to Bahar Dar where we saw the point where the Blue Nile emerges from the lake. Thence we followed the course of the Blue Nile valley for about one hundred miles to the vicinity of Debre Markos, where the river turns sharply west. This valley presents a fantastic landscape, the result of water erosion over millions of years. It exhibits a chaotic scene of plateaus intersected by innumerable gorges and chasms with steep slopes and in places perpendicular walls, in which the silvery thread of the river and its frequent tributaries flow. This gorge of the Nile is only comparable with the famous Colorado Grand Canyon. The escarpments and slopes of the plateaus are dotted with scrubby bush, which also frequently lines the edges of the fields on the plateaus. The pressure of population seems to be quite heavy, for the plateau lands are cultivated and thousands of tiny fields cover their flat tops. The small villages are mostly concentrated on the very edges of the escarpment like swallows' nests, so as to leave as much land as possible for cultivation. Not only is the arable area intensively utilized, but many of the steep slopes are also cultivated; bush fires were visible on all sides; and man-made erosion was everywhere visible in addition to the gigantic erosion caused by nature.

To improve the land-use pattern of this ultra-rugged region will require intensive study. It is evident that population pressure is very heavy and that there are many interrelated problems in the associated fields of agriculture and forestry, which are likely to be resolvable only through a prolonged investigation on the spot of all their socio-economic aspects."

France

• A true appraisal of the benefits to forestry from the reduction in the numbers of rabbits owing to myxomatosis will not be possible for some time. The disease, for the time being at least, shows some weakening of the virus and consequently there has been a reappearance of the rabbit population in limited numbers both in France and elsewhere in Europe where the rabbit has long been the bane of foresters.

From a forestry point of view it is clear that as a result of the work of the disease natural regeneration of tree crops has been definitely helped. In pure or mixed coniferous high forest, it is obvious that even after a bad fruiting year, seedlings are appearing wherever the soil is suitable for germination whereas, before the disease, it was impossible to find even a single seedling in rabbit-infested areas. More uniform and abundant regrowth and the subsequent natural selection among more trees, should permit a wider choice of elite trees which could logically produce better stands. It should, in turn, benefit the soil, which will eventually produce better timber. In many Scots pine and maritime pine stands in Sologne and on the dunes of Gascony, natural regeneration is no longer a problem.

Coppice sprouting is now extremely vigorous, and instead of bushy or

topped stools, the coppice produces fine, long straight shoots. The greater vigor and greater abundance of these shoots is good for the soil, and should produce stands of greater commercial value.

On barren heaths (*landes*) where the soil is already too seriously degraded, planting will still be necessary. But new opportunities now exist for making plantations without incurring heavy expenses for fencing and protection. Plantation work becomes practicable and normal again, with appreciable chances of success even in bad years. Investments that landowners formerly hesitated to make, can now be financed out of the National Forestry Fund, and many areas ruined by rabbits can thus revert to their original vocation as woodlands. However, the reappearance of rabbits has meant that many plantations which were set out in 1955, now again need protection, but this time it is less expensive than when rabbits were too numerous.

It is not possible, at present, to foresee the future course of myxomatosis. It is unlikely that the rabbit will disappear entirely. Probably in a few years, the disease will lead to total, or at least partial, immunization, and will then become endemic. From two to five years will have to elapse before a firm opinion can be given.

• The French paper industry, which is rapidly expanding, must seek to use an increasing proportion of homegrown timber, especially hardwoods, of which there is a considerable surplus. This trend necessitates a detailed inventory of national timber resources and an investigation of marketing and price conditions.

It is planned to carry out two surveys in France:

1. A national forest resources survey is to be undertaken by the forest authorities with the object of determining more precisely the quantities of timber that French forests can provide. This inventory — the method for which has now been decided — will be based on statistical sampling.
2. An economic survey of the market for wood for heating and industrial uses. Its principal aim so far as the paper industry is concerned will be to determine the conditions under which this industry can be supplied with the timber it needs, without competing with the demand for wood for heating purposes. Fuelwood often commands prices higher than those paid by the paper industry. The survey will comprise a sample coverage of forest owners and timber firms, consumers of wood for heating purposes, retailers of wood stoves, and firewood suppliers.

A pilot survey has already been carried out in two French *départements*, with satisfactory results.

Germany, Federal Republic

• At the beginning of the forest year 1957, the Federal Ministry for Food, Agriculture and Forests started with the preparation of studies for the assessment of a timber-balance. This is a first attempt to analyse, in co-operation with all groups of consumers and producers, the detailed structure of timber consumption as compared to national wood production plus imports. The aim is both a long-term and a short-term review of the timber market and a forecast of prospective trends in supply and demand.

The review is based on statistics of:

1. removals, sales and price development of roundwood;
2. production, stocks and price development of processed wood;
3. import and export of roundwood, sawnwood and processed wood.

A periodic inventory of stocks held by the timber trade, including importers, and in secondary manufacturing industries, will be added in the future. Statistics on end-use consumption do not exist in the Federal Republic, and it would be technically too difficult to collect them.

The balance worked out at the beginning of each year on the basis of the above statistics should permit clearer forward estimates of market prospects. No attempt will be made to analyse all economic and business trends which will affect progress of the market because of the actual lack of end-use statistics and the fact that prewar data are no guide to trends now, the results of the studies are not likely to be made public for the time being.

At the end of each forest year, the actual outcome will be compared with the estimates. The detailed analysis of national consumption should be improved step by step.

India

• An official report to the Asia-Pacific Forestry Commission includes information on the organization of private woodlands and co-operatives.

Private woodlands exist only to a very small extent and even the few privately-owned areas are likely to come under State control in the near future. As wood-based industries in the country still depend on the State forests to supply them with their requirements, there are no woodlands as yet devoted to the production of their requirements under any form of private management.

In Orissa and Bombay, some private forests have been placed by the owners under state management and these forests are looked after as if they were reserved forests. Elsewhere private forests are controlled by Acts of Legislature adopted to regulate their working, e.g., the Private Forest Protection Act of Madras which extends to parts of Kerala State also in the south and the Himachal Pradesh Private Forests Act in the Western Himalayan tracts. These regulations obligate the owner to obtain government permission in advance of any clearings, fellings or removals he plans in his forests. In some cases, privately owned forests (e.g., Punjab and Bengal) are managed under working plans properly prepared under the technical supervision of the State Forest Department. In a few States, even the felling of individual trees by any private owner is restricted by suitable legislation (e.g., Saurashtra Tree Felling Act in Bombay State).

Large-scale experiments to vest forest management in co-operatives (village *panchayats*) proved a failure in Madras, and the State Forest Department has had to resume management of the forests, though, unfortunately after much damage had been done to the growing stock. Co-operative societies have, however, shown remarkable progress in the management of forests placed in their charge in the Punjab but under general guidance of the Forest Department. Bombay has successfully evolved methods for the produce (fuelwood) of minor forest areas to be worked by co-operatives of tribal forest workers.

Indonesia

• In the course of the investigations for the preparation of the Forest Industrial Development Program for Indonesia by an FAO officer, special attention has been devoted to the fuel problem of the country.

Fuel consumption for heat and power is still characterized by the predominance of fuels from organic sources, i.e., firewood, charcoal and to a smaller extent, agricultural residues.

The result of the preliminary investigations on the total consumption of fuel can be summarized as follows:

Source of energy (heat and power)	Quantity	Equivalent firewood	Percent
	.... *million tons*		
Fuel from organic sources (firewood, charcoal including agricultural residues)	28.2	28.2	85
Coal	0.76	1.3	4
Mineral-oil	1.6	3.5	10
Hydro-electric power	..... *million kwh.* 400	0.32	1
TOTAL		33.32	100

Per capita consumption of different types of fuel is:

Type of fuel	Consumption per year	
	Actual consumption	Equivalent in firewood
	..... *kilograms*	
Fuel from organic sources	350	350
Coal	9.5	16
Mineral-oil	20	44
Hydro-electric power	*kwh.* 5	4
TOTAL		414

The breakdown of wood fuel requirements of the major groups of consumers (in terms of cubic meters of solid wood) is:—

		million m³
Households (about 1 kg. of woodfuel *per capita* and per day)	about	41.6
Smallholders rubber (smokehouses)	,,	0.99
Small food industries	,,	0.81
Ceramic industries (Lime, bricks, tiles, etc.)	,,	0.68
Railways	,,	0.58
Batik-works	,,	0.14

Comparison of consumption or production

Timber consumption (including unrecorded production)	about	4
Fuelwood consumption (including charcoal)	,,	45

(*Ratio, timber: fuelwood* = 1 : 11)

Firewood consumption (excluding charcoal)	about	39
Charcoal consumption (In terms of roundwood)	,,	6

(*Ratio, firewood: charcoal* = 6.5:1)

Recorded fuelwood production	about	2
Unrecorded	,,	43

(*Ratio,* 1 : 21)

During the last few years the above structure of fuel consumption has changed due to the tremendously fast increase of kerosene consumption which has developed as follows:

Year	Kerosene	Petrols
	..... *million liters*	
1938	322.2	190.0
1950	325.0	446.0
1951	384.0	505.2
1952	461.6	558.8
1953	593.3	605.8
1954	740.9	685.7
1955	894.4	694.1

This has been caused by:

(*a*) the very low price level, fixed by the Government.

(*b*) the great differences in prices for firewood in the various parts of the country.

(*c*) the low efficiency of cooking devices for use of firewood in comparison to the high efficiency of modern cooking devices for kerosene.

Whereas points (*a*) and (*b*) have to be adjusted by government policy, considering the economic and social needs of the country, point (*c*) has to be solved by international co-operation, i.e., by improving the cooking devices according to modern technical experiences and by encouraging training courses to introduce these experiences in rural and urban areas (e.g., smokeless *chula* from India).

The Indonesian Forest Department is sending some of the cooking devices used in Indonesia to the Fuel Laboratory of the Central Forestry Organization of Switzerland. Tests are to be conducted in co-operation with FAO to find out what saving of fuel can be achieved by various design improvements and what investments will be required, keeping in mind the principle that the construction of stoves should as far as possible be done by householders themselves.

Iraq

• In the mountain oak forests of Iraq, the tree crop provides forage as well as branch wood. The nomadic Kurdish tribes which pass over the mountains to spend the summer in Iran, returning to Iraq in autumn, depend upon fresh foliage for fodder during their return journey and hack branches off the trees haphazardly. Depending on the state of the grass and the weather conditions at both ends of their journey, they may stay in the forests for a matter of days, merely passing through, or they may spend several weeks on the

IRAQ. *This photograph by an FAO officer shows firewood stored in the fork of a big oak tree, and a shelter of poplar poles roofed with oak coppice shoots and branch wood obtained by pollarding.*

journey. They appear to travel over well-defined routes; one valley near the Iran border which the FAO officer visited was due to suffer the passage of about 2,000 families during the next two months. There is a special agreement between the two Governments which regulates the passage of these people.

The settled mountain people also make use of the foliage in the same way, but in addition they gather branches which they store in crooks of trees near their houses. This dried foliage or *chillu* is used for winter fodder. At least in some areas this is cut in a reasonably systematic manner and all the trees in one place, perhaps a few hectares in extent, will be roughly pollarded the same year while an adjoining area is left for the following year. There is no fixed cutting rotation but there is some semblance of systematic working.

Japan

• Reporting to the Asia-Pacific Forestry Commission, the Japanese delegate stated that the pulp industry had been expanded rapidly for the past several years and the production in 1955 reached 1.87 million metric tons. The supply of logs is becoming acute, but with the advancement of pulping techniques, the pulping of hardwoods is economically feasible and more use of such species is being promoted. About 10 percent of logs used for the pulp industry in 1955 were hardwood. Approximately 70 percent of the pulp mills are integrated with paper or chemical fibre manufacturing and most of them are on a large scale and dominant in the pulp industry. Modernization of plants in keeping with technical progress is significant. The number of plants decreased by 6 percent in 1955, but production capacity increased by 12 percent.

The fibreboard industry is also showing active development. The number of plants of the industry in 1955 was 24. With the expectation of growing demand for construction and other fields, each company is planning expansions and the production capacity at the end of 1957 is expected to be four or five times as much as that of 1956.

The wood particle board industry started at the same time with fibreboard manufacturing as a new wood processing industry and has developed remarkably. The annual production of the industry in 1955 was 10,000 tons and is now about 20,000 tons. Considering the planned expansion program, even greater production is expected.

Kenya

• It is reported that a Paper defining the Government of Kenya's policy on forest resources has been tabled in the Legislative Council in Nairobi. Entitled *A Forest Policy for Kenya*, the Paper lays down the basic principles which will guide the development and control of forestry "for the greatest common good of all". The Paper describes Kenya's forest estate as ranking high as one of the country's most important national assets. It has a protestive aspect in its conservation of climate, water and soil; it is the source of forest produce for all uses by the people of Kenya; and is a revenue earner of high potential.

The basic principles in the Paper are contained under ten main headings — the reservation of land for forest purposes; the protection of the forest estate; relations with timber utilization industries; finance; employment; relations with African local authorities; private forests; public amenities, and research and education.

Recognizing the value of the forest estate, the Government is determined to reserve the existing forests in perpetuity and wherever possible to add to them. Enough timber will be produced to meet requirements under a fully developed national economy and to provide the greatest possible surplus for exports. The need for fuel supplies in African areas will be met, as well as the requirements of towns for as long as other fuel supplies are not available at an economical rate.

Explaining this policy, the Paper says that the total area of all forest reserves is at present only 2.91 percent of Kenya's total land area. "The Government regards this as a dangerously low percentage", it continues, "and its policy is to increase and demarcate the area under forests as far as is practicable, having regard to other land use and to availability of finance".

Experience over the past 20 years has shown that Kenya can grow exotic tree species, particularly softwoods, at a cost and in a time which should enable the resulting timber to be placed on world markets at competitive prices. The Government intends to develop both types of forest products, to encourage the export industry and, where practicable, to foster timber using processes in Kenya.

All forests will be managed in accordance with specific plans approved by the Minister, and the express approval of the Minister will be needed for any important departure from an approved plan. An inventory of forest resources is to be compiled as soon as possible. Forest management will take into account the use of the timber produced and the special requirements of the industries and markets concerned. The Government intends to hold consultations at all stages between the Forest Department and the timber milling, marketing and exporting industries.

In the financial field the Government will provide adequate funds for the realization of its policy within the limits of available money.

The Government is convinced that the ultimate success of its forest policy depends largely on the practical application of scientific research. Adequate provision must be made for high level scientific research, and for the training of forest staff to apply to results of research to the best advantage. Within the limits of finance, the Government intends to maintain for itself an adequate scientific staff, and to make the fullest use of research institutions within the country and outside it. It also intends to maintain its own training school to provide practical training in forestry at the sub-professional level.

Liberia

• The School of Forestry is an integral part of the University of Liberia. After a certain amount of preparatory work, the School started in February 1956 with a freshman class of eleven students and with a sophomore class of two students who had started their work in the previous year. FAO furnished the teaching staff.

Now in 1957 the School of Forestry runs a freshman class of twenty students and a sophomore class of eleven students. During the next two years this school will continue to be built up, so that in 1959 it will have all four classes of the ordinary university school of forestry.

A school forest as outdoor laboratory is in preparation. The whole research work of the School of Forestry is also just in the preliminary stages, but there is general agreement that it is a very urgent task to start forest research at the earliest date and on a larger scale, if the School of Forestry is to play its full role.

No other school of forestry exists either in West Africa or in Central Africa, which means that this Liberian School of Forestry is the only one to train academic foresters in Africa itself and to handle all the manifold scientific problems of the African rain forest on the spot.

For Liberia itself the necessity for such a School of Forestry is shown by the following facts:

(*a*) The Republic of Liberia is forested over 80 percent of its surface, but has as yet no sustained forest management of this natural resource.

(*b*) There is a consequent need for the creation of a solid forest administration body of state foresters as well as of those for communal and private forests.

(*c*) In connection with modern practice of forestry there will be a development of the timber industry in general and of its different branches to a much larger extent than before.

(*d*) National Parks will be created for recreational purposes, not least for the preservation and observation of wild life.

It is estimated that the country may need 70 to 100 well-trained academic foresters for the forestry program within the next 10 to 12 years.

LIBYA. *Twenty hectares of maritime sand dunes at Ajedabia, Cyrenaica, were fixed with dis* (Juncus *sp.*) *in July 1956 and direct sown with seed of* Acacia cyanophylla *in February 1957. Normally 6 to 8 months old seedlings of* A. cyanophylla *are planted in the stabilized areas immediately prior to the winter rains. March* 1957.

The second photograph shows A. cyanophylla *in the second season after planting. No watering. Annual rainfall is 70 millimeters. The use of any woody vegetation for fixation hedges requires careful protection as it is subject to illicit cutting for use as fuel.*

Malaya

• An official report to FAO says that, in 1955, the Silvicultural Research Committee recommended that the forests of the country which had been regenerated by silvicultural operations, should be sampled to discover the composition of the new crops of different ages in terms of species, girth class distribution, basal area, timber volume and height of dominant trees. A pilot scheme for sampling the 17,000 acres (6,800 hectares) of regenerated forest in the State of Perak was implemented in the latter half of 1956. The design was a stratified random sample at an intensity of one percent.

Experiments in reforesting land which has been abandoned and degraded by poor agricultural practices or by mining, have been initiated by the ecologist. Both exotic and local species are under trial. Partial cultivation appears a promising means of establishing trees in areas of sheet *lalang* (*Imperata cylindrica*). Among the exotic, *Pinus insularis* and *P. caribaea* are so far doing well in *lalang* areas whilst *P. merkusii* is showing promise on barren areas of spoil from tin mines. Of other exotics, *Maesopsis eminii* is showing remarkable growth in its early years.

New Zealand

• The progress report submitted to the last session of the Asia-Pacific Forestry Commission indicates that with the steady expansion and continued prosperity of pastoral farming in New Zealand, the pressure of demands for the release of forest land for agricultural use has not abated. The land-use committees (composed of experts in the fields of agriculture, forestry, soil conservation and land development) appointed to advise the Government on the final disposal of land, the use of which is disputed, have thus been fully occupied, and many large areas will have to wait some years for decisions. However, the trends towards piecemeal release

MEXICO. *The first National Exhibition of Forest Industries was recently opened in Mexico City by the Minister of Agriculture, Mr. Gilberto Flores Muñoz, and was later visited by the President of the Republic. The Exhibition was a demonstration of the actual development of the Mexican forest industries and the great potential value of Mexican forest resources. By means of attractively presented displays, nearly one million visitors were shown the application of wood in building construction, and its use in railways, naval constructions, prefabricated houses, containers, furniture, cellulose and paper, plywoods and fibreboards, musical instruments. Also displayed were uses for the secondary products of the forest, such as rubber, resins, fibres, essential oils and so on. The photograph shows the stand presented by FAO, illustrating with photographs, charts and publications, the activities of the Organization and its assistance to member countries.*

of fertile lands and the acquisition of land needing permanent protection has progressed well, and the Forest Service has now acquired control over a very large proportion of all coastal sand dunes that require fixation.

Establishment of new production-forest resources, both privately and publicly owned, continued steadily between 1954 and 1956. But because of conditions affecting land use described above this has been very largely confined to land already held as forest land. Acquisition of new areas for production forestry is hindered by the very high cost of land in those regions where a timber shortage makes afforestation particularly desirable. For this reason the Forest Service has encouraged farm forestry as an alternative source of timber supply.

Good progress has been made in the protection of catchment areas; and the predominant role of the Forest Service in this work is now fully recognized. This has enabled the extension of Forest Service control over many critical mountain areas throughout New Zealand. Management of these protection forests has also been successfully adapted to serve the recreational needs of the community.

• In 1955, the Tasman pulp and paper project was completed and is producing timber, pulp and newsprint. The New Zealand pulp and paper industry has now completed its first stage in the utilization of the big exotic forests in the North Island and further expansion is already in the planning stage.

Timber production has reached an all-time record. The indigenous softwoods show a slight decrease, but exotic species continue to increase. Prospects for bigger exports of timber to Australia are very promising, though New Zealand must make every effort to improve marketing to meet competition with American and Baltic softwoods.

New Zealand is now by far the world's largest producer per head of population of timber preservatively treated for building purposes. Species of timber available, traditional methods of house construction and developments in preservation techniques are the main reasons for this. The increase in the use of exotic softwoods which are more liable to decay and no less susceptible to insect attack than indigenous timbers, and the difficulty of ensuring throughout the life of a building that moisture cannot enter any part, demand the wide use of preservative-treated timber. Much controversy has naturally arisen regarding the effectiveness of various types of treatment and the extent to which treated timber should be used in a building.

In September 1955, the Government, in order to resolve these questions, set up a Timber Preservation Authority. The principal function of the Authority is to secure and maintain a high standard of timber preservation. All treatments carried out must be in accordance with the requirements of the Authority, which has established an inspecting organization under the New Zealand Forest Service. Already the Authority has adjudicated on and approved a number of specific methods which were previously the subject of controversy. Notably the application of boron compounds by diffusion has been accepted for all timbers requiring treatment for light building construction other than those for use on contact with the ground. The regulations under which the Authority functions permit it to prescribe that no preservative-treated timber can be marketed unless the treatment and the marking of the timber agrees with the Authority's requirements. Progress in preservation practice and use of treated timber will now be accelerated.

Treatment of exotic forest thinnings is continuing to fall short of demand, although treatment facilities are steadily being increased. This treatment enables this otherwise low utility produce to be used for farm and engineering requirements where durability in the ground is important.

Pakistan

• The first Pakistan Silvicultural Conference was held in May at Abbottabad. Presided over by the Inspector-General of Forests, Mr. Y. S. Ahmad, it was attended by Conservators of Forests from East and West Pakistan, silviculturists, and the officers of the Pakistan Forest College and Research Institute. The proceedings have been issued,

In this connection, an FAO officer reports on desert areas of West Pakistan that there are appreciable parts in Tharparkar, Cholistan, and the Thal where either a substantial stocking of trees still exists or which hold promise of being able to grow trees. Such areas, up to 20 percent of the total area, should be selected for reservation as forests. Areas which carry a substantial stocking of tree species, even though browsed to bush form, should be immediately reserved. A photographic survey has been made for practically the whole of West Pakistan, and the mosaics should be very helpful for selecting the areas for retention as forest, and for choosing the areas for immediate reservation.

There are good indigenous species which grow to a useful size in these difficult conditions. They grow slowly but they would grow better in protected plantations. They should be used until experiments and research find exotic species which will give better and quicker growth. The many species of *Eucalyptus* offer a fruitful field for study and some experimental work has already started.

Reserved forests would not necessarily be closed to grazing, except where necessary in the interests of the tree growth. Most of them could be managed under a system of dual use, but grazing would need to be closely controlled and goats and camels completely excluded.

• A detailed report to the Asia-Pacific Forestry Commission states that during the last five years a number of important forest industries have been established in Pakistan to meet the essential needs of the country. Some of the developments in this direction are outlined below.

Practically all conversion of logs is carried out by hand sawing either in the forest or at the collection points. Only in the large consumption centers, circular and hand saws are used for the production of sawn lumber. As soon as mechanical extraction of timber starts in East Pakistan a big sawmill capable of ultimately handling 30,000 tons of round logs per year, is expected to be set up near Chittagong to convert the round logs which will be extracted from Chittagong Hill Tracts. One modern plywood factory, having a production capacity of 30,000 square feet (2,800 square meters) of plywood per day, has recently been set up in Karachi and is producing plywood, block boards, flush doors and other similar products of various grades. No fibreboard or chipboard plants have come into existence so far, although chances for these industries are quite promising in both wings of the country. With the new match factories now set up in Chittagong, Khulna and Karachi, the number of such factories has increased. The Landhi Factory is producing annually 45 lakhs gross boxes while Khulna Factory has a capacity of 9 lakhs gross boxes per annum. The present output is able to supply an appreciable part of the total demand which is estimated at 9.5 million gross boxes per year. Considerable progress has also been made in the manufacture of paper and cardboard. A big paper mill for the production of 30,000 tons of paper per year from muli bamboo available in Chittagong Hill Tracts has been installed at Chanderaghona. Two factories producing high-grade boards and various qualities of paper are nearing completion at Nowshera and Rahwali. These mills will utilize grasses and rice straw for this purpose and each will have an annual output of 7,500 tons. A project for the manufacture of 30,000 tons of newsprint paper per year at Khulna from gewa wood available in the Sunderbans is also under active consideration at present.

Out of the old industries existing in this country, mention may be made of the manufacture of sports goods at Sialkot. The main raw material for the sports goods industry is mulberry wood grown in the irrigated plantations of the Punjab forests. The major proportion of the goods produced in Sialkot are exported to meet established foreign demand for these articles.

No regular manufacture of doors, windows or other materials needed for house building is carried out in this country. These are all made manually by the local carpenters engaged for this purpose. A practically similar situation holds good in respect of furniture which is being manufactured in large cities on a small scale. There is no modern furniture plant for the large scale production of utility articles. With the installation of a big sawmill at Chittagong, a fabrication plant for the manufacture of furniture is also expected to be added to the integrated forest industries unit that is proposed to be set up in East Pakistan.

Paraguay

• An FAO technical assistance officer with the assistance of local forest engineers, has been studying natural regeneration in the Paraguayan forests, both in virgin and cut-over lands. The areas described are: 1. the central area, east of the Paraguay river, and the most populous zone of the country; 2. the area of Concepción still east of the same river, but further north; 3. area of the Alto Parana River; 4. area of the Chaco with predominance of *Schinopsis balansae*. He also mentions the extension of this area, going west towards the Bolivian boundary, where the predominant species of potential value is *Schinopsis lorentzii*, which also occurs abundantly in Bolivia even though it is not under exploitation; it is intensively used on the Argentine section of the same phyto-geographical area.

The exploitation of all these areas is purely selective with no regard to silvicultural conditions, which has of course an important bearing on the regeneration possibilities of the main species. He lists over 32 different species of which, nevertheless, only five are of immediate and present commercial value. Some of the other species are used sometimes locally for fuelwood and fence posts.

The composition of the forests of the three regions east of the Paraguay river is basically the same with respect to the important five species, locally known as "*especies de ley*". Variations in occurrence are more remarkable for the secondary species. The terrain elevation rises from west to east, from 200-300 to 1,000 meters; and in the same way the rainfall increases from 1,000 to 1,800 millimeters. The average temperature is about 23°C, of a continental type of climate, with periods of drought in winter, and a difference of over 11°C between the extreme average temperatures for the coolest and hottest months.

The study shows that none of the important species reproduce adequately in virgin forests, but it is also evident that they do not do better in cut-over areas mainly because of the selective cutting. Such cutting, in certain cases, leaves no seed trees, and in others does not leave enough clear openings for light demanding species. *Cedrela tubiflora* (*C. fissilis* var. *macrocarpa*) regenerates well along the roads and in cut-over areas but is very severely attacked by *Hypsipyla grandella*. This attack is more frequent in the Alto Parana area; a 100 percent attack was found in small plantations.

In the Chaco area, especially in connection with the quebracho, it was found that three different systems of extraction were carried out. The most suitable form of cutting permits regeneration by leaving enough trees over 30 centimeters, but this is basically a contractual matter between the mill and the loggers.

A forest nursery, for the production and use in reforestation of natural and exotic species, is being organized near Asunción by the *Departamento*

Forestal of the *Ministerio de Agricultura y Ganadería,* with the help of American bilateral aid, and is expected to be in operation by the end of the current year or beginning of 1958. The FAO officer is supervising and helping in the preparation of a tree planting manual which will be used as part of the background material for *Tree Planting Practices for Latin America,* which will complete the series of similar FAO Forestry Development Papers prepared for other regions.

Philippines

• The Director of Forestry reported to the Asia-Pacific Forestry Commission on the reorganization of the Department of Agriculture and Natural Resources which has been passed by the Congress of the Philippines. Under the reorganization plan, a Commission on Parks and Wild Life is created to be attached to the Bureau of Forestry for purposes of policy and programming co-ordination. The College of Forestry is entirely placed under the University of the Philippines and the Forest Products Laboratory, a functional division of the Bureau of Forestry, is re-named Forest Products Research Institute. This is to be an autonomous unit, but attached to the University of the Philippines for purposes of administrative supervision. The plan provides for the position of an Assistant Director of Forestry. The plan also regroups activities and functions for the more efficient discharge of the Bureau's responsibilities.

Two laws have been approved:

1. An Act requiring the registration of agents, contractors, and dealers in logs, lumber and commercial piles.
2. An Act to amend certain sections of the Pasture Land Act, by restricting persons leasing or using public land for pasture to graze one head of large cattle belonging to the lessee for every five hectares, and providing additional penalty for the violation of the Act.

The policies governing land classification as undertaken by the Bureau of Forestry are embodied in the *Revised Guiding Principles for Land Classification.*

Portugal

• In the history of the cultivation of cork-oak in Portugal, 22 December 1956 was a noteworthy date. It marked the first of the practical achievements of the Commission for the Development of Cork-Oak Growing in gaining additional land on which to extend the raising of cork-oaks throughout Portugal. Simultaneously at Alentejo and Trás-os-Montes, the first planting of acorns to form the future cork-oak groves was carried out by the Under-Secretaries of State for Agriculture and for Commerce and Industry. Since then, 150 tons of seed, carefully selected, have been distributed during the course of this year's campaign.

These efforts, widely supported in the press, have been made possible through a close co-operation between the National Cork Junta and the Forest Department, with the support of growers. They clearly show that the need and significance of rehabilitating cork-oak cultivation have been apprehended and approved as a move towards the forest development of the country.

The action of official bodies was for a long time limited to the laying down of regulations for the cork-oak industry. Only in the last ten years, since 1946, has progress been made in providing training and demonstration courses, and extension services to owners of cork-oak groves. It has been recognized that this alone was not enough. It was necessary to find answers to the many problems associated with the management and proper exploitation of the cork-oak woodlands and, in particular, to secure the restocking of suitable areas with this species where it had long disappeared and elsewhere to restore a better density of stocking so as to make the whole business of growing cork-oak more economic, prevent soil deterioration, and permit the full utilization of available land resources.

Due credit must be given to the efforts made by many private owners over the last 15 or 20 years: many formerly cleared areas have been gradually restocked, either by planting or through protection of the natural regeneration. Young thriving stock is to be found in profusion in scattered areas. But the task on the national scale is still so immense and difficult that these isolated efforts are insufficient by themselves. It is necessary, indeed essential, to co-ordinate all the separate efforts and willingness to help into a national program for the protection and development of cork-oak growing. A campaign for the expansion of cork-oak growing has long been advocated by the Permanent Working Party on Cork of the FAO Mediterranean Subcommission. In the Mediterranean region, it should be possible to recover for cork-oak growing some millions of hectares of degraded or deforested land, and introduce better cultivation techniques in place of the often primitive and devastating current practices combined with farming and grazing.

A Commission for the Development of Cork-oak Growing was set up in Portugal in September 1955 for the purpose of implementing the measures deemed necessary for the development of the cork-oak resources of the country. Subsidies provided to the various services of the *Junta Nacional de Cortica* have made it possible to start work on a wide spread scale this year.

Sarawak

• The broad assessment of forest resources, with the more detailed inventory and stock-mapping of permanent forests, is still one of the major tasks of the Forest Department. The examination of the peat-swamp forests and mangrove swamps, which cover a total area of more than 5,000 square miles (13,000 square kilometers), is now almost complete. Inventories of permanent forests, usually combined with detailed stock-mapping, covered 2,150 square miles (5,600 square kilometers) at the end of 1956, as compared with 1,276 square miles (3,300 square kilometers) at the end of 1953.

Land-planning in general is largely in the hands of the Natural Resources Board, which was considerably enlarged in 1955 to include more unofficial members. The Conservator of Forests is an *ex officio* member of the Board. One of the principal functions of the Board is to study and make recommendations on all proposals concerning the constitution or revocation of Permanent Forests.

The demand for more agricultural land is becoming very pressing, particularly on the part of Sea Dayaks whose bush-fallow rice lands are becoming exhausted. The Sarawak Government has recently set up an Internal Migration Committee to study the whole problem and to organize resettlement where it is necessary. It is hoped that such resettlement may be effected under conditions that will lessen the evils of shifting cultivation. The present Conservator of Forests is chairman of this committee.

To facilitate the work of the Internal Migration Committee, the Department of Lands and Surveys, assisted by the Forest Department, is preparing a land use map which, it is hoped, will be completed early in 1957. The map shows not only present land use, but also attempts to show potential land use. With this objective, the principal natural

vegetation types are shown on the map, as a broad guide to soil types.

Under the FAO technical assistance program, a soils expert was attached to the Forest Department during 1955 and 1956, to study the very poor sands (usually podsolised) known as *kerangas* in Sarawak. These soils cover many hundred square miles. It is hoped that the study may provide a practical guide to their future use.

The constitution of a permanent forest estate, however, is still a major task of the Forest Department. At the end of 1954, the total area of this estate was 9,592 square miles (25,000 square kilometers), or 20.4 percent of the total land area. During the period 1955-56 it has been increased to 10,560 square miles (28,500 square kilometers), or 22.4 percent of the total land area.

At the end of 1954, the total area of permanent forest managed under systematic working plans was 638 square miles (1,660 square kilometers). By the end of 1956, this had been increased to 923 square miles (2,400 square kilometers). In addition, the exploitation of a considerable number of swamp forests, that are not included in the Permanent Forest Estate but that are not likely to be alienated within the foreseeable future, is controlled by simple felling plans, providing for fixed annual coupes and a girth-limit for the felling of the more valuable species.

Singapore

• With the exception of some very small reserved areas of Crown forest and city catchment areas, which still contain some of the original flora, the original forest on Singapore Island has been destroyed and only small patches of nonproductive secondary forest remain. The small forest areas that have survived are managed by a Board of Management under the Nature Reserves Ordinance, 1951, and not by the Forest Office, whose main functions are:—

(*a*) the grading and supervision of grading of timber under the Malayan Grading Rules for both local and overseas markets,

(*b*) advising generally on the grading and utilization of Malayan timbers both in Singapore and overseas.

An official report to FAO states that processing for local consumption and for export of timber, plywood, rotans, damar and gums from raw materials imported from the mainland and surrounding territories, is a major local industry. The most important of these processing industries is the production of sawn timber and of plywood. Twenty major sawmills, one large modern plywood factory, and several small mills, and resawing and woodworking plants are in production. All the sawmills are owned by Chinese and are operated exclusively with Chinese labor, the output of the largest being about 60 tons of sawn timber per day and that of the smallest less than 5 tons per day.

The main sources of supply of logs for the sawmills in Singapore are the Federation of Malaya, particularly Johore, and the neighboring islands of Indonesia, particularly Sumatra. Though total imports increase, supplies are still often not adequate to enable all mills to work at full capacity.

Imports also include sawn timber which is either in transit for export overseas or intended for consumption in Singapore. The following Table shows the total imports of sawn timber:—

IMPORTS OF SAWN TIMBER (EXCLUDING TEAK) FROM ALL SOURCES
(*in tons of 50 cubic feet*))

Region	1953	1954	1955
Indonesia	2,478	2,543	4,247
Elsewhere	29	160	110
TOTAL, OVERSEAS	2,507	2,703	4,357
Federation of Malaya	36,529	31,683	48,217
GRAND TOTAL	39,036	34,386	52,574

Teak does not grow naturally in Malaya and as there is a considerable demand for it, particularly in the furniture trade, substantial quantities are imported, mostly from Bangkok. The amounts imported for the last three years are as follows:

Year	Quantity	Value
	(*tons of 50 cubic feet*)	(*Straits* $[1])
1953	8,272	4,676,673
1954	6,081	3,171,775
1955	7,196	3,545,636

[1] 3.03 Straits dollars = 1.00 U.S. dollars.

Spain

• A report to the European Forestry Commission says that the resin industry, comprising 82 factories engaged in distilling resin to obtain by-products, is of considerable importance to the Spanish economy. The resin factories employ seasonally from 12,000 to 14,000 workers for nine months of the year; the resin production season lasts for that period.

The annual output is about 43,000 metric tons of resin; in recent years there has been no noticeable fluctuation in these figures. The production of turpentine has been rather steady. There have been periods of shortage of colophony, due largely to increased home demand and demand from abroad from countries who traditionally buy Spanish colophony and turpentine. Sideline industries using colophony as their raw material are the 190 factories producing synthetic (resin) soap, four factories making metallic resinates, and the paint and varnish factories.

Switzerland

• The possibly harmful effects of insecticides and fungicides on forest trees, used in agriculture to combat insects, has been the subject of research in Switzerland for some time.

Concern had been voiced over a number of years by ornithologists, beekeepers and nature protection circles as well as foresters over the destruction of insects by chemicals. They have pointed out the harmful after-effects of such control measures on useful animals and birds and how they upset the natural biological equilibrium. The effects on forest trees may be of two kinds. First, the jeopardizing of the fruiting because of the killing off of the seeds; second, preparations with a Hexa base can have direct effects upon tree growth and quality of the timber.

Special working parties have carried out research over a period of ten years into the harmful effects of these chemical products. Experiments have not lead to conclusive results, but have rather proved negative as regards the effects upon forest trees. It is noteworthy, however, that up until now, neither insecticides nor fungicides have been used in Switzerland to combat forest tree diseases or parasites.

• Switzerland's board industry, which produces boards of all kinds, has expanded greatly and improved its production in recent years. Processed boards are being increasingly used in the building and furniture-making industry. The board industry makes possible a practically complete utilization of saw logs. The demand of the industry for sawmill waste, other than sawdust, has increased to such an extent that there is already a shortage, despite the fact

that the wood saccharification factory had to stop operations in the middle of 1956 as a consequence of a negative public vote in the Federation.

As a means to absorb the sawdust no longer used by the factory, research is under way to make saccharification cheaper either by the Scholler or Rheinau process for the derivation of products from sawdust more valuable than alcohol, which does not pay. The making of sawdust bricks fuel has proved profitable under certain working conditions because of the high prevailing prices paid for solid fuels. In the meantime, small quantities of sawdust are still used as a base for linoleum, wall boards, in brick factories and by butchers.

The Swiss paper and cellulose industry is continuing to use mainly softwoods, rather than hardwoods or residues, although the interest of manufacturers in the latter two is growing. With improved sorting and grading it should be possible to place larger quantities of softwood on the market — about 300,000 cubic meters. The conversion of small size timber does not figure very largely, although projects are under study for the erection of a sulphate process factory. At present cellulose is being produced in Switzerland only by the bisulphite process.

Taiwan

• *A Forestry Program for Taiwan* issued by the Joint Commission on Rural Reconstruction quotes an example of a China fir (*Cunninghamia lanceolata*) plantation yielding N.T.$10,000 per hectare (U.S. $160 per acre) from a light thinning 5 years after planting, the cost of which did not exceed N.T.$2,000. This return is comparable in value to agricultural crops. It will continue annually and will increase rapidly with age. It requires less expenditure of money and labor and is better land management on marginal soil types. *Cunninghamia lanceolata* is an exotic species introduced from the mainland about 100 years ago. A local species (*Cunninghamia konishii*) appearing in certain localities grows even faster.

Another exotic that finds itself at home in the environment of Taiwan is the Luchu pine, introduced from Okinawa about 50 years ago. According to the Taiwan Forest Research Institute, Luchu pines "have grown to 0.5-0.8 meters in breast-height diameter in 25 - 30 years... moreover sometimes there are 45-year-old standing crops whose volume per hectare amounts to 850 cubic meters". According to *Forest Resources of Taiwan*, the forest survey also recently issued by the Joint Commission on Rural Reconstruction, "One 30-year-old plantation has trees 30 inches d. b. h. and with good height and form". Similar volumes are recorded for *Cryptomeria* of the same age. There are few places in the world where natural conditions combine to make forestry so productive.

Results of the same order can be cited from plantings of *Acacia*, *Cassia*, *Melia*, teak, *Casuarina*, slash pine, and other species, both native and introduced. A few of these are shown in the accompanying Table.

Thailand

• All teak concessions issued to foreign companies expired at the end of May 1955, and the Council of Ministers divided all teak forests in Thailand into three approximately equal each to be worked by one of the following agencies:

1. a government enterprise under the name of Forest Industry Organization (FIO) which has worked both teak and other hardwoods since 1947;
2. a joint concern in which the Government and the five foreign companies who had held previous leases participate;
3. *changvad* forestry companies formed, one in each province or *changvad*, with the major object of working the forests in their respective provinces, both teak and other forests which are not assigned to the Forest Industry Organization or to the joint concern.

As regards *changvad* forestry companies, any local inhabitants of the province can participate in the local company, but the Government holds majority shares for the purpose of guidance and control. The underlying policy of this project is to allocate forest resources of each province to the benefit of the local inhabitants and to instill forest consciousness among the general public, so that, it is hoped, indiscriminate exploitation or destruction of forests may be lessened or totally stopped.

The practice of shifting cultiva-

TAIWAN: COMPARISON BETWEEN AGRICULTURAL AND FOREST CROP RETURNS

Agricultural crops on agricultural lands		Forest crops on forest lands (plantations)				
Crop	Total[a] annual income (N.T.$/ha.)	Species	Harvest cutting (years)	Commercial volume (m^3) harvested[b]	Unit price (N.T.$/$m^3$)	Average[a] annual income (N.T.$/ha.)
Rice	12 864	*Cunninghamia*	20	200	1 800	18 000
Sweet potato	11 505	*Cryptomeria*	25	240	1 800	17 240
Pineapple	9 324	Pine	20	200	936	9 360
Jute	8 787	Camphor	30	300	900	9 000
Peanut	6 230	*Acacia*	15	150	792	7 920
Sugar cane	5 085	Teak	25	180	1 050	7 560
Cassava	3 998	*Cassia*	15	120	540	4 320

[a]) All values include harvest costs, which for forest products average from 20-40 percent.
[b]) Commercial volumes harvested are average net log volumes on medium sites.
The following explanatory notes accompany the Table:

1. The extremely high incomes from forest crops are due to the present abnormally high prices of forest products. No doubt, as the recently established plantations, and those which are planned for the near future, begin to produce commercial products, the prices of wood products will gradually go down. Still, it is doubtful that they will ever go down to the point where forest lands will yield less than agricultural lands.

2. The forest products, however, are grown on mountain lands with comparatively poor soils, and unsuitable in general for agriculture. If they are not yielding forest products, they would therefore yield nothing and would constitute a hazard to agricultural production in the form of erosion, water shortages, etc.

3. Forest yields result from but one planting followed by two years of tending after which nature does the rest until harvest time.

THAILAND. *A large-scale defoliation of* Casuarina *plantations located near the coast was reported by the FAO Regional Forestry Office in 1956. This proved to be caused by a locust* Aulaches miliaris, *which previously had not been regarded as of any great significance although known to be an occasional pest of trees and shrubs in India and Malaya. The Royal Forest Department reports that attacks occur only during the rainy season. Although young plants usually die, older trees suffer only a temporary set-back and eventually recover, the time taken depending upon the amount of rainfall. Control by an insecticide has been tried.*

tion by nomadic hill tribes in watershed areas is a constant drawback with regards to soil utilization and conservation. An attempt has been made to afforest the cleared areas with the object of stopping soil erosion and deterioration, but the appropriated budget for this project is always scanty, so only about 700 hectares of denuded land could be afforested in 1955 and 1956. Extension and demonstration services were also carried on at four already established watershed protection centers in the principal catchment areas, by introducing suitable perennial crops such as tea, coffee, tung-oil, fruit trees etc., for experiments in devastated areas with the ultimate aim of persuading nomadic hill tribes to settle permanently on the land. Satisfactory results have been achieved in this respect.

United States of America

• In 1949, as it became evident that the virtually untouched forests of southeastern Alaska were to be invaded by great pulp operations, the Alaska Forest Research Center of the U.S. Forest Service undertook a comprehensive and continuing study of the physical effect of logging on the salmon streams. Until that time the vast commercial catch of salmon, which averages 55 percent of that for the entire world, had been the dominant industry of the area. The project, in the planning of which experts in other official services were consulted, had two major parts, one a collection of quantitative information on type and effect of the physical change taking place in streams prior to logging, and, second, quantitative changes following logging.

Four streams were selected for continuing study; two of the watersheds would be logged. Continuing measurements of factors such as climate, streamflow, storms and associated runoff, base flow, water temperature, stream channel change, sedimentation and ground water levels have been under way. The project is planned and conducted primarily as a timber management undertaking, and aims to determine and define the physical changes which may result from timber utilization. A co-operative study is, however, under way by trained aquatic biologists and this will relate physical changes in the streams to the salmon which includes five major species. The prelogging calibration period is completed and logging has begun on one of the two watersheds to be cut.

This intelligently planned project should make it possible to identify any seriously adverse effects of timber utilization in time so that necessary modifications may be considered before whole streams are rendered useless for the fish.

• The U.S. Forest Service has made a comprehensive study of the recreational problems, and the development and maintenance programs required to make National Forest recreation a full-scale segment of the use of these areas.

The first real attempt to provide simple recreational facilities — namely public camping grounds — was made during the emergency period of the early 1930's, and since that time the recreational use of the forests has quadrupled and it has been impossible because of scanty funds appropriated for the purpose even to maintain the areas then developed, to say nothing of adding to them. Thus there has accrued a major task of rehabilitation of old areas, as well as selecting, planning and establishing new ones; an additional job that is only partly settled is the prosaic but necessary task of collecting and disposing of refuse and maintaining sanitation facilitities.

The study fits the recreational program into other programs for timber, range, watershed and other major values, and caters only to true forest type activities such as camping, swimming, hunting, fishing and the like. It is contemplated that special services and facilities such as large shelters for automobile trailers, electric lighting and so on will not be provided at public expense

UNITED KINGDOM. *Oak trees which had been growing in the Devon countryside for 250 years went into the building of the* Mayflower II, *constructed by craftsmen as nearly as possible to the design of the original* Mayflower *which sailed with the Pilgrim Fathers from England to the New World in 1620. The* Mayflower II *re-enacted this voyage in 54 days and is now on permanent exhibition in the United States.*

Courtesy: Stenners of Tiverton, England.

but will be provided by private enterprise if at all. Similarly, public service facilities such as automobile service stations and restaurants will not be constructed or operated, but left to private industry.

It is predicted that by 1962 the recreational use of the National Forests will increase from the 45.7 million visits which were recorded in 1955 to 66 million. The total cost of the program required to catch up and keep shead is estimated at $11.5 million in 1958, increasing to $19.5 million in 1960, after which it should remain relatively constant.

Venezuela

• Over an area of 30 million or more acres covered by deciduous forests, a serious fire problem exists. Fire is used as a tool in agriculture for clearing land, and carelessness with these fires has resulted in thousands of denuded acres. The livestock industry also traditionally uses fire as a means of removing old grass from the range in order to get fresh palatable forage. These fires run wild and continuous burning has resulted in a downward trend of desirable fodder species and an increase in the brush type more resistant to fire.

During the 1955/56 fire season, 700 fires were reported, and it is estimated that an equal number or more were not reported. A very good fire legislation exists and the *Departamento de Prevención y Extensión de Incendios* in the *Ministerio de Agricultura y Cria* has been entrusted with its application. The National Guard co-operates in fire control and also public bodies formed by agriculturists and livestock breeders, amounting to 33,000 members. There are all the elements, therefore, to create an efficient fire control.

For the purpose of organizing this control, FAO has furnished the services of a specialist from the United States. Several of his recommendations are now being implemented: decentralization of the fire control organization, modification of the fire reporting system, purchase of fire fighting tools, and a publicity campaign for fire prevention through conferences, radio and television. The presuppression program has been limited because of insufficient funds but many fire lines have been constructed, in particular around reforested areas; the construction of more lookout stations has been approved; and personnel are receiving appropriate training. As to suppression, this is a more complex problem and will take longer to solve.

A range management specialist is needed to demonstrate new practices that would eliminate traditional techniques of burning.

The Timber Pavilion designed for the Brussels World Fair, 1958.

Book Notices

An Outline of Norwegian Forestry Knut Skinmensoen. 104 pp. Illus. *Det Norske Skogselskap*, Oslo, 1957.

The Norwegian Forestry Society has just published in English a small booklet which gives, in a condensed form, a very precise idea of Norwegian forestry. It is an excellent contribution to co-operation between foresters on a regional and world-wide scale, and it is to be hoped that the example will be followed in many other countries and in other languages.

The plan of the booklet is simple and could be taken as a model. Having described in broad outlines the physical conditions of the country and its forest vegetation, it gives a clear statistical picture of the country's resources and of the structure of forest ownership. Two chapters are devoted to the historical development of the forest, to the effect of this on the present forestry situation and to the evolution of silviculture and management. Factors likely to cause damage to the forest are treated at some length. Then there is an important chapter on economics and forest policy containing statistical information on trends in the price of timber and interesting information on the cost of forest operations, the financing of development programs, and taxation. The chapters which follow are devoted to methods of felling and transport, to labor problems, the organization of administration, research and education, as well as a brief summary of the most important forest law of the country: the Forest Protection Act of 1932.

The second part gives an excellent survey of Norway's most important forest industry, pulp and paper.

The final pages are devoted to measures taken for the protection of wildlife and nature, and contain a list of the principal forestry associations and forest industries, as well as forestry periodicals. At a moment when European governments rightly attach so much importance to the problem of the small private woodland, it is very interesting to read how Norway has solved the problem by a strict application of the principle "freedom with responsibility". The booklet leaves one with the strong impression that Norway, which has more than 70 percent of its forests in private ownership, is extremely well organized to derive the maximum benefit from its forests in the national interest.

Storia del Diritto Forestale in Italia. (History of Italian Forest Law). Romualdo Trifone. 375 pp. – Accademia Italiana di Scienze Forestali, Firenze 1957.

This study is of interest for the amount and quality of the information which it gives on the development of forest law and legislation in the different periods of the history of the Italian peninsula. It also contains much of interest on the history of land utilization and the planned integration of the forest in this utilization. The case of Italy is of particular moment inasmuch as here is an example of a Mediterranean country, where the pressure of population on the land available for agriculture has been felt acutely for a long period. This history can be traced through from the first centuries of our era, and even for some centuries before that. Lastly Italian forest law directly stems from Roman law which has served as the foundation of jurisprudence of so many countries of Europe and the New World; it has also been subject to the influence of German law since the Middle Ages.

The book is divided into six main parts. The first examines the foundations of Roman law and Germanic law with regard to forestry. The second part describes the evolution of forest law from the 12th century to the beginning of the 19th century in each of the kingdoms, duchies and republics. The third summarizes the forest legislation of the various states on the eve of the unification of Italy. The three last sections analyze the progress of ideas in forest legislation from this period up to the decisive law of 25 July 1952.

One may be surprised to find that a number of characteristics which might have been thought to be contemporary were already in existence in one of the Italian States centuries ago. The idea of restricting the rights of the private forest owner when the destruction of his forest is against the general interests of the State, although quite contrary to the principles of Roman law, goes back to very ancient times. The need to control public rights of usage also appeared quite early. Certain States early imposed restrictions not only in relation to land and water protection but for economic reasons: provision of fuelwood for certain industries, and above all provision of timber for ship building. From the 17th century onwards, the Venetian Republic had a very elaborate body of forest legislation in this regard. As to the public forest rights many elements were already contained in Roman law, with the distinction which has remained fundamental for so long, between the *selva caedua* and the *selva non caedua*.

The pervading feature of the history of Italian forest legislation is undoubtedly the deliberate intention firstly not to divorce forestry from the general rural and agricultural economy, and particularly from the economy of mountainous country.

Hough's Encyclopaedia of American Woods. E. S. Harrar. 240 and 25 pp. Illus. Distributed by Interscience Publishers Inc., 250 Fifth Avenue, New York, 1957. U.S. $25.00.

The fourteenth and final volume of the original series of this classical work was published in 1928, four years after the death of its author, Romeyn Beck Hough. A completely new version is being published of which Volume I is at present available. Further volumes are planned to appear every six months.

Each volume of the new version consists of two parts. The first part is a text volume written by Dr. Harrar containing up-to-date information on the habitat of the tree and the structure and utilization of woods. The second part consists of three wood sections of each of 25 woods, many of them the actual wood sections by the late Romeyn Beck Hough. Others will be cut as required, using machines of his design.

Fifteen volumes, dealing with 25 woods each, will be devoted to American woods. Additional volumes will be devoted to European woods, exotic woods, and wood technology.

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Prepared by the Forestry Division of the Food and Agriculture Organization of the United Nations, the eleventh *Yearbook of Forest Products Statistics* includes information of world forestry output, trade and consumption from about 130 countries for 1956, with revisions made in 1955 figures as available. The publication carries world production tables, technical notes, country notes and a leading chapter entitled " Salient Features of the World Situation, 195 ".

Returns from countries reporting to FAO, as well as other official sources and estimates, cover approximately 95 percent of the total world production of roundwood, 97 percent of lumber, 97 percent of plywood, 96 percent of woodpulp and 99 percent of newsprint.

Issued in one trilingual (English, French and Spanish) edition, the Yearbook is available on order through any authorized FAO sales agent at U.S. $2.50 or 12s. 6d. or the equivalent in local currencies. Ready in November 1957.

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The Journal, official organ of the Society of American Foresters, is a professional magazine devoted to all branches of technical forestry. It is published monthly for, and by, practising foresters. The editor is assisted in selecting material by a group of associate editors, each a specialist in his field: wildlife management, genetics and artificial regeneration, management and engineering, range management, economics and policy, pathology and entomology, mensuration, silviculture, watershed management, wood utilization, and forest fires.

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